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Feed Grinder Investigations

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FEED GRINDER INVESTIGATIONS

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The grinding of feed on the farm is becoming a more common practice. This increased interest on the part of the farmer to do his own grinding is due in no small measure to the application of electricity to agriculture. The tractor sometimes has its disadvantages as a source of power for the feed mill. It may be busily engaged at some farm operation which cannot be stopped readily; therefore, grinding is generally done after the field work is over. Considerable time may be required to belt the tractor to the feed mill, and in some instances it is impossible to place the feed mill in a convenient location and still be able to belt the tractor to it. The electric motor furnishes a steady, even flow of power which is very necessary to obtain the highest efficiency in feed mill operation. Furthermore, with the proper installation, grinding can be done at practically any time of the day.

There are two general types of feed grinders now on the market—burr mills and hammer mills. Another type of mill is built which may be rightfully termed the combination mill. This mill employs burrs or hammers for grinding purposes and, in addition, is equipped with a feed table and cutter head for grinding roughages and ear corn.

BURR MILL

The burr mill is so termed because of the burrs used for reduction purposes; the hammer mill employs hammers, either rigid or swinging, for the same purpose.

The burr mill is usually constructed with a hopper mounted above a shaft which carries the burrs, auger or crusher hook, and cone breaker. In the bottom of the hopper and mounted on the shaft is the crusher hook or cob breaker. This device crushes the materials, as well as functioning as an auger to force the materials toward the grinding chamber. On practically all mills a concave is mounted beneath the auger, which assists in the reduction process and also in deflecting the grain toward the grinding chamber. On some mills this device is adjustable. The agitator is sometimes mounted above the auger or slightly to the side of it. This device functions to keep materials from packing tightly in the hopper, to

NOTE: Only the larger types of feed mills were used in the test work. Results may differ slightly from those of the smaller, or 5-H. P., sizes.

prevent bridging, and to break whole ears of corn. On some mills it force-feeds the material to the crusher hook. To eliminate packing or plugging in the throat leading to the grinding, or burr, chamber a cone breaker is installed on the main shaft at a point back of the auger and ahead of the burrs.

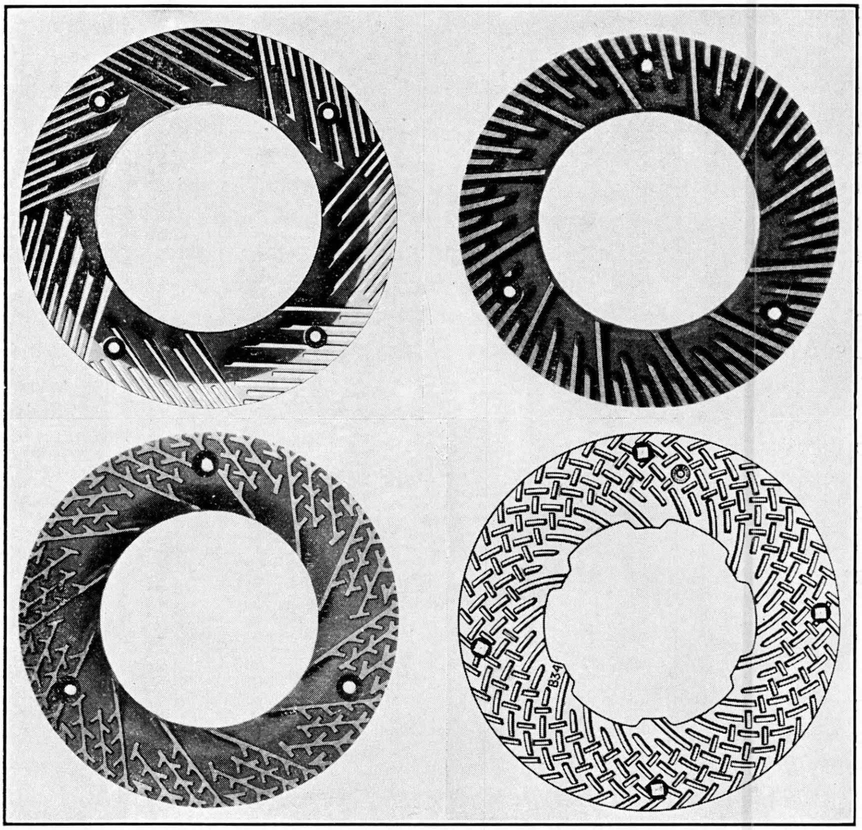


Fig. 1.—Common types of grinding burrs

Courtesy of Letz Manufacturing Co. and Stover Manufacturing and Engine Co.

There are two burrs used—one pinned or bolted to the main shaft and the other, which is self-aligning, held by the body of the mill. This burr does not revolve. Some burrs have only a single grinding surface whereas others are double, making them reversible. Various types of corrugated or shearing surfaces are employed to meet the requirements for fineness of grinding and kind of materials to be ground. These are termed coarse, medium, and fine plates or burrs. (Figure 1).

The fineness of grinding is regulated by the type of burr used, by the distance the burrs are apart, and by the speed and capacity of the mill. Adjustment is accomplished by an adjusting screw under spring tension, which moves the revolving burr out or in until the desired fineness is reached. The spring tension equalizes the pressure between the burrs when any irregularities of feeding take place. Although fine grinding can be accomplished by medium burrs, it is not to be recommended, inasmuch as the horsepower increases considerably and there is rapid wear on the burrs.

On practically all burr mills a "quick release" is installed to permit the burrs to be thrown apart quickly when some hard, foreign material gets to the grinding chamber and enters between the burrs. The release is also used to hold the burrs apart until the grain enters between them or when feeding stops. Under no condition should the burrs be held apart by this device when the mill is doing normal grinding. The rate of feeding is accomplished by slide gates located in the throat of the grinding chamber. As the material leaves the grinding chamber it is dropped into a bucket elevator or exhaust fan to be elevated into the bin or sack. The hopper type of burr mill is intended for grains only, as no roughage can be ground unless the roughage has previously received some reduction.

COMBINATION MILL

BURR TYPE

The combination burr-type mill is designed to grind roughage in addition to grain. These materials can be ground separately or together. In addition to a grain hopper which is mounted similarly to that on a burr mill, a force-feed feed table and cutter head are attached. Roughages and ear corn are fed by the feed table to the cutter head. After the material is cut finely, it is then conveyed to the grinding chamber for further reduction.

Ear corn, as well as other grains, may be fed through the hopper where it passes directly to the grinding chamber. On most mills of this type the feed can be cut only or it can be cut and ground. The general type of knife used is the spiral type. Various lengths of cut are obtained by changing the speed of the feed apron. On some makes of mills of this type two shear bars are employed to give a double shear to one revolution of the knife head (Figure 2).

Under the cutter head is located a screen, the purpose of which is to retain the larger particles to be recut and permit the smaller particles to pass through and on to the grinding chamber. These screens may be of various sized mesh, depending on the fineness desired. Inasmuch as cutting takes considerably less power than grinding, it is important that reduction in the size of the feed particles be done by the cutting process to relieve the grinding as much as possible. This type of mill is very satisfactory where mixing of grain with roughage is practiced. On some mills a dust remover is installed to eliminate excessive dusting at the cutter head.

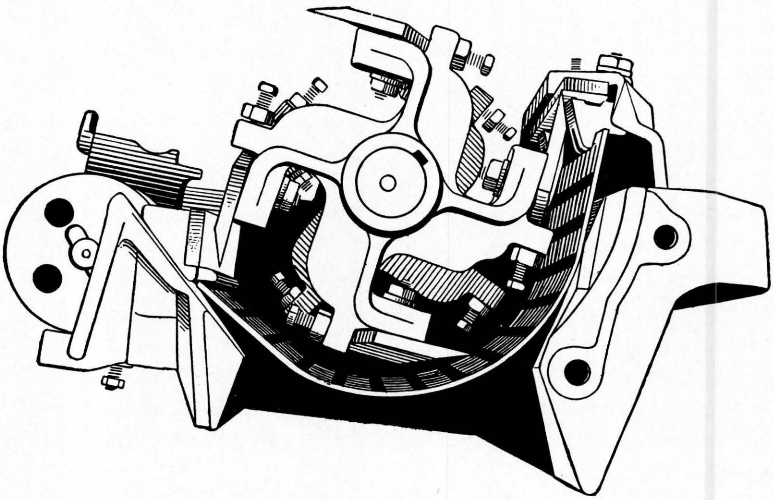


Fig. 2.—Type of cutter head commonly used on combination mills of the burr type

Courtesy of Letz Manufacturing Co.

HAMMER MILL

The hammer mill is the most recent machine for the purpose of grinding grains and roughages. This type of mill generally consists of a number of revolving hammers mounted on a shaft, or rotor, set centrally through the middle of the chamber or housing. As the material is fed through a feed hopper the hammers strike it with great force, resulting in rapid pulverization. At a point close to the periphery of the hammers is located a screen. As the material is reduced in size it falls through the screen into a settling chamber, where it is elevated either by an exhaust fan or bucket elevator. The fineness of grinding is accomplished by using different sizes of screens, ranging on some mills from 1/16-inch opening to 2½-inch.

Practically all hammer mills are equipped with an adjustable feed table. Some are adjustable to height, and practically all of them can be tilted. A slope is necessary in grinding grains to permit the grain to flow evenly into the hammer chamber. For roughage grinding the table is usually set in a level position. At the back of the feed table and at a point just ahead of the hammer points is an adjustable gate which regulates the flow of grain to the mill. This is the "gravity" type of feed. Some mills are equipped with a positive feeding device, such as rollers or similar devices. (Figure 3). In addition, a governor may be installed to prevent overloading of the mill.

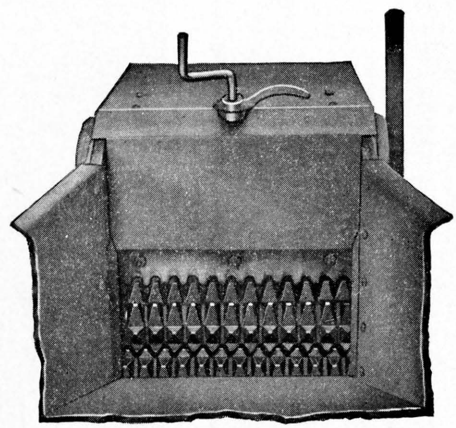


Fig. 3.—Device for positive feeding

Courtesy of Papec Machine Co.

Practically all hammer mills are run at high speeds. In order to accomplish this it is sometimes necessary to install some form of speed-jack. The mills with the greater distance from one hammer point to the opposite hammer point usually have the lesser speeds and are sometimes driven directly without a speed-jack. This usually lessens the "no-load" power requirement of the mill and incidentally leads to greater efficiency in pounds of feed ground.

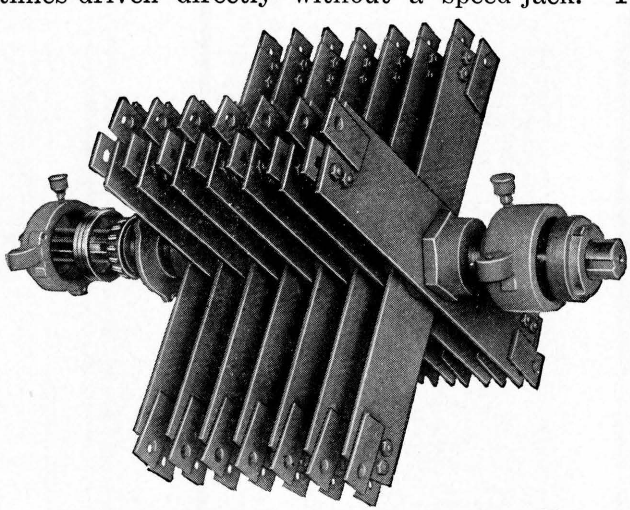


Fig. 4.—A common type of rigid hammer. Note the removable tips

Courtesy of Papec Machine Co.

There are really three rather distinct types of hammer mills—the rigid hammer type, the swinging hammer type, and the triple or double reduction process type. The latter type is sometimes termed combination grain and roughage hammer mill. The rigid hammer type of hammer mill (sometimes called the semi-rigid type) is characterized by the rigid, or straight, hammer (Figure 4). These hammers are usually fastened to the shaft by means of jam-nuts. By this method of holding, the hammers can slip on the shaft when some heavy or hard material enters the grinding chamber. This eliminates breaking or bending the hammers. On some mills the hammers are set in line and on others they are staggered. The hammer tips may be split (Figure 5), or they may be installed with removable tips, as shown in Figure 4. In either case the hammers or tips can be reversed when wear takes place.

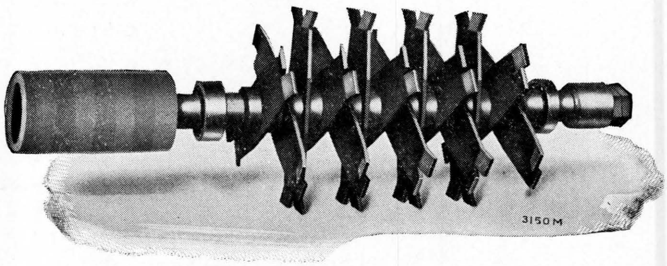


Fig. 5.—Rigid type of hammer with split tips

Courtesy of Fairbanks, Morse, and Co.

The swinging type of hammer is hinged and free to swing. This type of hammer on different makes of mills may be of various lengths and designs. The tips may be notched or they may be

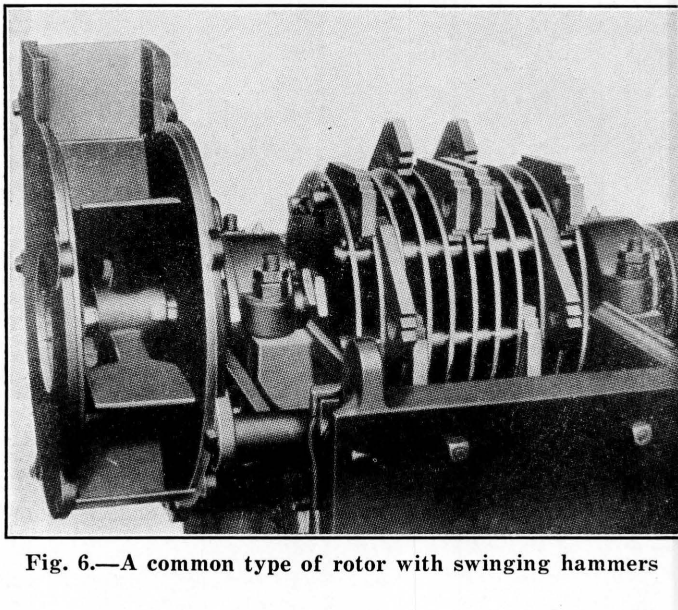


Fig. 6.—A common type of rotor with swinging hammers

plain, and usually the hammers can be reversed to give four wearing edges. The rotor as shown in Figure 6 illustrates a popular design of hammer assembly.

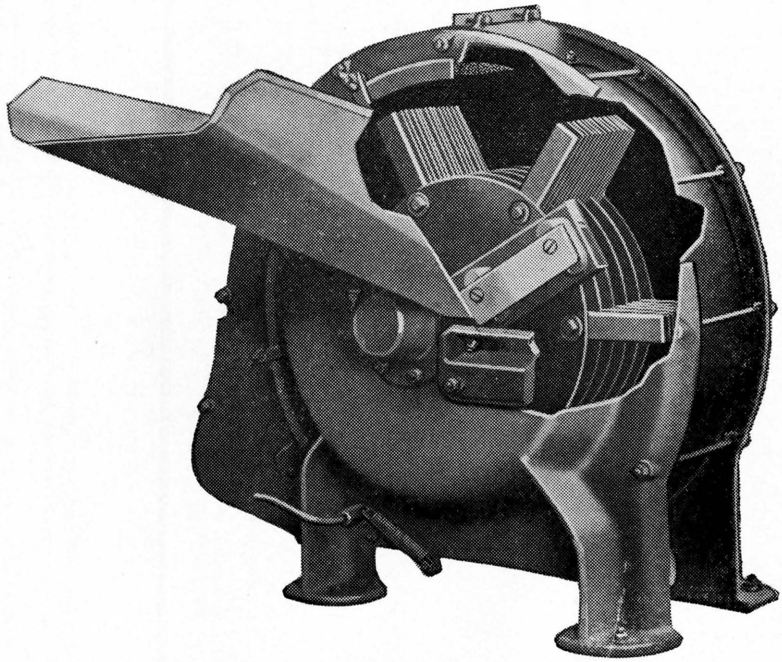


Fig. 7.—Rotor showing cutter head in addition to hammers

Courtesy of Prater Pulverizer Co.

The combination type of hammer mill, which is sometimes known as a triple reduction process mill, contains, in addition to hammers, some form of cutter head. In Figure 7 the triple reduction process hammer mill is shown with the flywheel type of cutter head, discs, and hammers for reduction purposes. The material is fed from the side of the machine where it first comes in contact with the knives. The cut material then passes to a second chamber where it is pulverized further by the rapidly revolving discs. A further reduction is then made by the material coming in contact with rapidly revolving swing-type hammers which are light and spaced closely together. This completes the third and final reduction. Other types of combination hammer mills are built which contain a cutter head in addition to one set of hammers. The spiral type of cutter head is commonly used on this mill.

Automatic self-feeders with governors are fast becoming a standard piece of equipment on hammer mills. This device is especially desirable when grinding roughages. It feeds the material to the mill evenly and steadily and eliminates plugging to a great degree. Even, steady feeding is essential for high efficiency in operation.

Due to the excessive speed of hammer mills and the fact that an exhaust fan is becoming universally used for elevation purposes, considerable dusting is created. To eliminate excessive dusting a feed collector (Figure 8) is employed as a settling chamber. The material is elevated by the fan to the feed collecter where it is then delivered to sacks or bin. It may be held in position by supports attached to the mill or by a separate structure known as a "tower".

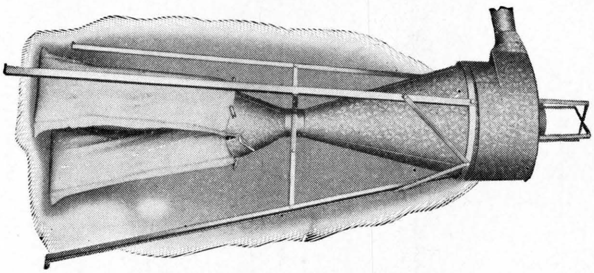


Fig. 8.—A type of feed collector used as a settling chamber

Courtesy of Letz Manufacturing Co.

Hammer mills are simple in construction and, as a general rule, require very little expense for repair or replacement of parts. There is very little chance for breakage should any hard substance enter the mill. The hammer mill will grind grains and roughage although the rate of grinding roughage is not high when compared with the cutting process.

FINENESS OF GRINDING

In grinding feed, great importance should be attached to the fineness to which the material is to be ground. This is important from the nutrition, as well as from the power, viewpoint. Difference of opinion exists among farmers and commercial feed men as to what grade of fineness constitutes a coarse, medium, or fine product. In Table 1 a classification is given which denotes coarse, medium, fine, and very fine grinding. This classification is based largely upon the size and nature of the whole product itself. The modulus of fineness is the only accurate method for determining the fineness. It is the method recommended and adopted by the American Society of Agricultural Engineers. The modulus of fineness is simply a number given to the average size of particles in a representative sample. For test work this method for determining the fineness of grinding is especially desirable.

TABLE 1.—Classification of Moduli of Fineness for Various Finenesses of Grinding on the Common Grains and Roughages

	Whole grain	Coarse grinding	Medium grinding	Fine grinding	Very fine grinding
Grains					
Ear corn	....	4.80 (5.40—4.20)	3.60 (4.20—3.00)	2.40 (3.00—2.10)	1.80 (2.10—1.50)
Shelled corn	6.00	4.80 (5.40—4.20)	3.60 (4.20—3.00)	2.40 (3.00—2.10)	1.80 (2.10—1.50)
Barley	5.00	4.10 (4.50—3.60)	3.20 (3.60—2.70)	2.30 (2.70—1.90)	1.50 (1.90—1.30)
Oats	4.50	3.70 (4.10—3.30)	2.90 (3.30—2.50)	2.10 (2.50—1.70)	1.40 (1.70—1.20)
Soybeans	6.00	4.80 (5.40—4.20)	3.60 (4.20—3.00)	2.40 (3.00—2.10)	1.80 (2.10—1.50)
Wheat	5.00	4.10 (4.50—3.60)	3.20 (3.60—2.70)	2.30 (2.70—1.90)	1.50 (1.90—1.30)
Roughages					
Corn stover	....	5.50 (6.00—4.80)	4.20 (4.80—3.50)	2.90 (3.50—2.20)	....
Corn fodder	....	5.50 (6.00—4.80)	4.20 (4.80—3.50)	2.90 (3.50—2.20)	....
Soybean hay	....	4.00 (4.50—3.50)	3.10 (3.50—2.60)	2.20 (2.60—1.80)	1.40 (1.80—1.30)
Alfalfa hay	....	4.00 (4.50—3.50)	3.10 (3.50—2.60)	2.20 (2.60—1.80)	1.40 (1.80—1.30)
Clover hay	....	4.00 (4.50—3.50)	3.10 (3.50—2.60)	2.20 (2.60—1.80)	1.40 (1.80—1.30)

NOTE: Corn Stover—No ears of corn attached. Corn Fodder—Ears of corn attached. Upper and lower limits for fineness in parentheses.

HOW FINE SHOULD FEEDS BE GROUND?

The fineness to which to grind feed is a debatable question. This much is true, however, that livestock men are now grinding their grains at a much coarser grade than in previous years. Experiment Station studies seem to indicate cheaper gains from feeding livestock with the more coarsely ground feed, which in turn increases the capacity of the mill and lowers the power consumption in grinding and the wear on the mill.

In an effort to recommend or standardize as closely as possible the finenesses of grinding most suitable for all classes of livestock, including poultry, the Animal Husbandry and Poultry Departments of the Ohio State University have made some valuable recommendations. Grains and roughages were ground at various grades of fineness and submitted to the above departments for their approval. The results of this work are given in Table 2.

By referring to the photographic classification (Figures 9 to 17) a very true picture of the size of particles can be had for the recommendations given in Table 2.

TABLE 2.—Fineness of Grinding for All Classes of Livestock, as Recommended by the Animal Husbandry and Poultry Departments

Feeds	Fineness of grinding	Beef cattle	Dairy cattle	Dairy calves	Swine	Sheep	Lambs up to 8 wks. of age	Horses		Chicks	Hens	
								Wet mix	Dry		Scratch	Mash
Shelled corn	Grade	Med.-coarse	Medium	Med.-coarse	Whole	Whole	Med.-coarse	*	†Whole or very coarse	Fine-medium	Med.-coarse	Med.-fine
	Modulus	4.20	3.60	4.20			4.20		5.00	2.80	4.20	2.80
Ear corn	Grade	Med.-coarse	Medium	Med.-coarse	Whole	*	*	*	Whole	*	*	*
	Modulus	4.20	3.60	4.20								
Oats	Grade	Med.-coarse	Medium	Medium	Medium	Whole or very coarse	Whole or very coarse	Med.-coarse	Rolled	Fine	Whole	Fine
	Modulus	3.20	2.80	2.80	2.80	4.00	4.00	3.20		2.10	4.50	2.10
Barley	Grade	Very coarse	Med.-coarse	Fine-medium	Fine-medium	Fine-medium	Fine-medium	Med.-coarse	Rolled	Very fine	Whole	Very fine
	Modulus	4.50	3.60	2.90	2.90	3.00	3.00	3.60		1.50	5.00	1.50
Soybeans	Grade	Whole	Fine-medium	Coarse	Very fine	Very coarse	Very coarse	*	†Very coarse	Fine	*	Fine
	Modulus	6.00	3.10	4.80	1.80	5.00	5.00		5.00	2.40		2.40
Wheat	Grade	Coarse	Medium	Coarse	Medium	Very coarse	Very coarse	*	†Rolled	Fine	Whole	Med.-coarse
	Modulus	4.10	3.20	4.10	3.20	4.30	4.30			2.30	5.00	3.50

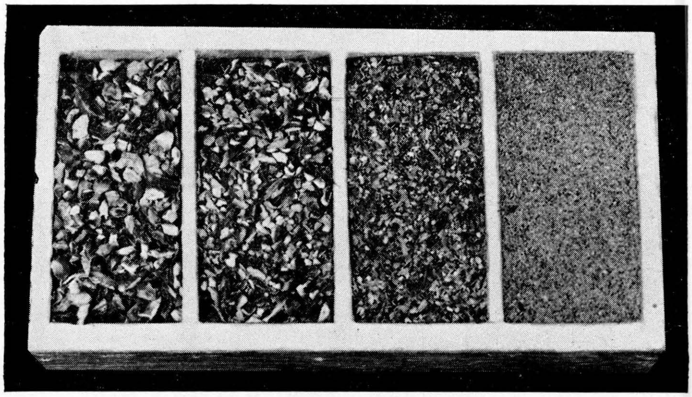
*Not recommended. †Seldom fed.
NOTE: Contributed by Animal Husbandry and Poultry Departments, Ohio State University.

TABLE 2.—Fineness of Grinding for All Classes of Livestock, as Recommended by the Animal Husbandry and Poultry Departments—Continued

Feeds	Fineness of grinding	Beef cattle	Dairy cattle	Dairy calves	Swine	Sheep	Lambs up to 8 wks. of age	Horses		Chicks	Hens	
								Wet mix	Dry		Scratch	Mash
Rye	Grade	Coarse	Medium	Coarse	Medium	Very coarse	Very coarse	*	†Rolled	*	*	*
	Modulus	3.70	2.90	3.70	2.90	3.90	3.90					
Alfalfa	Grade	Whole	Whole and fine for mixtures	Coarse	Very fine–fine	Whole and fine for mixture	Whole	Chopped	*	Very fine	Very coarse	Very fine
	Modulus		2.20	4.00	1.40	2.20				1.40	6.00	1.40
Soybean hay	Grade	Whole or very coarse	Whole or coarse	Whole or coarse	Medium	Whole	Whole	Chopped	Whole	Very fine	Very coarse	Very fine
	Modulus	5 .00	4.00	4.00	3.10					1.40	5.00	1.40
Clover hay	Grade	Whole	Whole	Whole	Medium	Whole	Whole	Chopped	Whole	Very fine	Very coarse	Very fine
	Modulus				3.10					1.40	5.00	1.40
Corn fodder	Grade	Shredded	*	*	*	*	*	*	*	*	*	*
	Modulus	6.00										
Corn stover	Grade	Whole	Whole	Whole	*	Whole	Whole	*	Whole or shredded	*	*	*
	Modulus								6.00			

*Not recommended. †Seldom fed.
NOTE: Contributed by Animal Husbandry and Poultry Departments, Ohio State University.

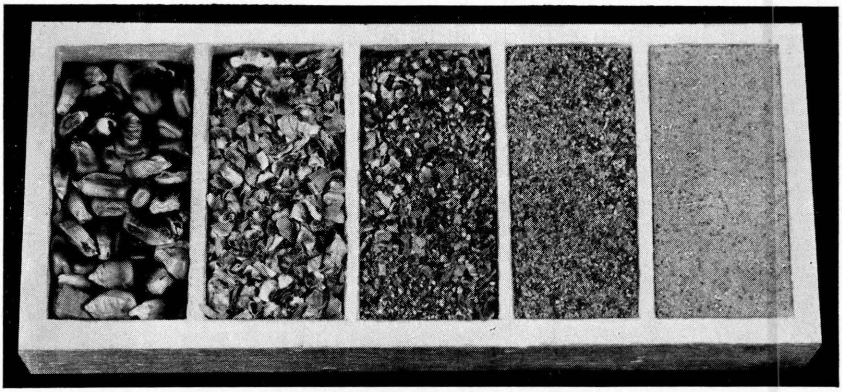
EAR CORN



Coarse 4.80 | Medium 3.60 | Fine 2.40 | Very Fine 1.80

Fig. 9.—Classification of grinding, showing relationship between grade term for fineness and modulus number

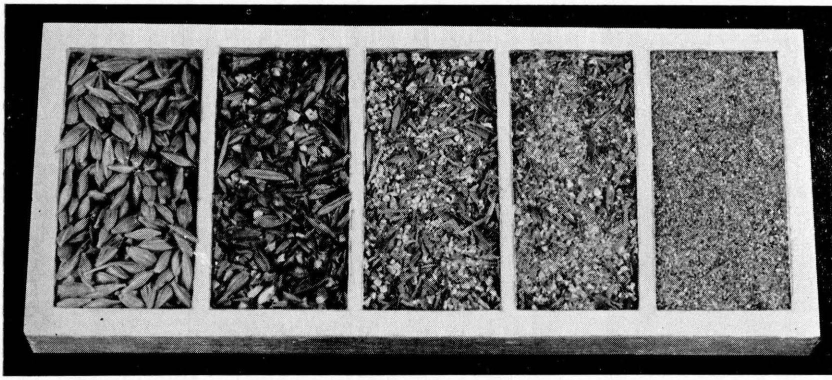
SHELLED CORN



Whole 6.00 | Coarse 4.80 | Medium 3.60 | Fine 2.40 | Very Fine 1.80

Fig. 10.—Classification of grinding, showing relationship between grade term for fineness and modulus number

BARLEY



Whole	Coarse	Medium	Fine	Very Fine
5.00	4.10	3.20	2.30	1.50

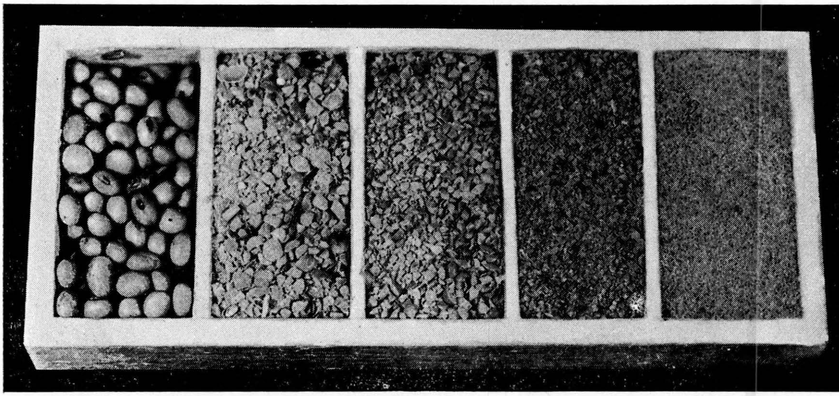
Fig. 11.—Classification of grinding, showing relationship between grade term for fineness and modulus number

OATS

Whole	Coarse	Medium	Fine	Very Fine
4.50	3.70	2.90	2.10	1.40

Fig. 12.—Classification of grinding, showing relationship between grade term for fineness and modulus number

SOYBEANS



Whole	Coarse	Medium	Fine	Very Fine
6.00	4.80	3.60	2.40	1.80

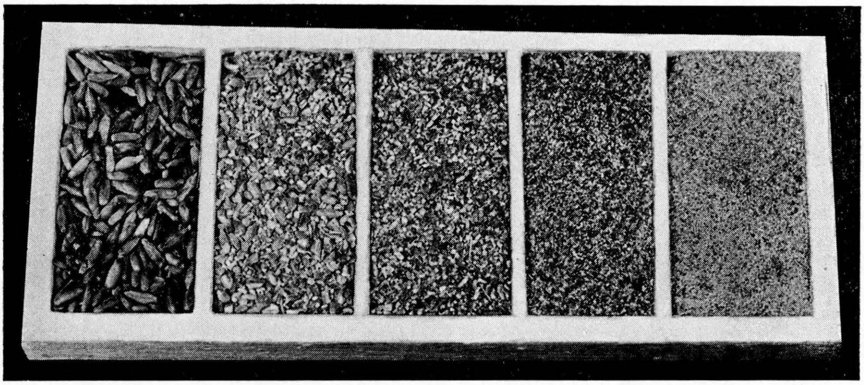
Fig. 13.—Classification of grinding, showing relationship between grade term for fineness and modulus number

WHEAT

Whole	Coarse	Medium	Fine	Very Fine
5.00	4.10	3.20	2.30	1.50

Fig. 14.—Classification of grinding, showing relationship between grade term for fineness and modulus number

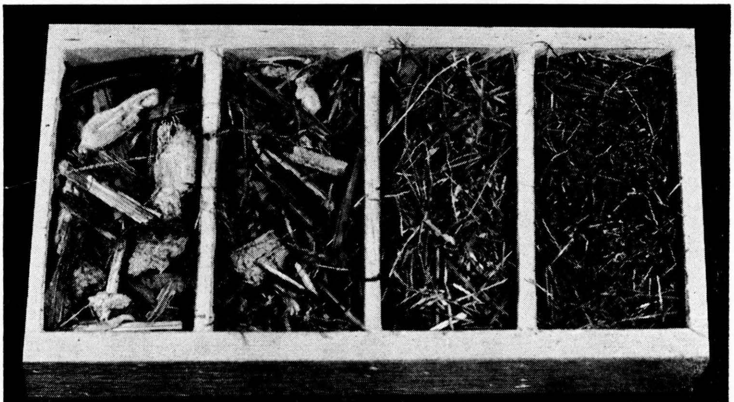
RYE



Whole	Coarse	Medium	Fine	Very Fine
4.50	3.70	2.90	2.10	1.40

Fig. 15.—Classification of grinding, showing relationship between grade term for fineness and modulus number

CORN STOVER AND CORN FODDER



Coarse	Medium	Fine	Very Fine
5.50	4.20	2.90	1.60

Fig. 16.—Classification of grinding, showing relationship between grade term for fineness and modulus number

LEGUMES

Coarse 4.00 | Medium 3.10 | Fine 2.20 | Very Fine 1.40

Fig. 17.—Classification of grinding, showing relationship between grade term for fineness and modulus number

GRINDING POULTRY FEEDS[1]

It has been found by observation and experimental studies that poultry prefer granular feeds to those that are finely ground. For this reason it is not advisable to grind any feed so fine that it will pack or so fine that it is impossible for the chicks to pick out the coarse particles. It is an excellent theory that a finely ground feed can be mixed with certain ingredients, such as powdered milk and meat scraps, which of necessity are rather fine, and that in this way each bit of feed consumed would contain all of the ingredients of the ration. The theory breaks down, however, under actual experience, and we find that the increased palatability of the feed when it is coarsely ground is a desirable advantage which we do not have when all the feed mixed in the mash is very fine.

Corn for laying hens should be ground just as coarsely as possible to allow that all of the kernels be broken. The necessary fineness will depend a great deal upon the moisture content of the corn; if the corn contains a high percentage of water, it is well to grind it a little finer than when the water content is very low.

Corn for baby chicks must be ground considerably finer than for laying hens. This is due to the inability of the chick to swallow the larger particles, but even for baby chicks the corn should be quite granular rather than flour-like.

Wheat should be ground just as coarsely as possible for both chicks and hens. Even when ground very coarsely a great deal of the wheat will be fine, and the whole product can be mixed very well with both the laying mash and the baby-chick mash. Oats should be ground rather finely, because a certain amount of fiber in the ration is desirable, and unless the oats is ground rather finely the poultry have a tendency to leave it in the mash box.

Alfalfa leaf meal need not be ground as finely as it ordinarily is for commercial purposes, but if the whole alfalfa is ground, then it will be necessary to grind it finely; otherwise, the stems will be left in the feed box.

CHARACTERISTICS OF FEED GRINDING

In order to arrive at some of the relationships between some of the various types of feed mills and to learn some of the characteristics of feed grinding, a series of tests was made during the fall of 1929 and the spring of 1930. Twelve mills were loaned by the manufacturers for test purposes. Of this number, four were burr mills, two were combination burr-type mills, two were rigid or semi-

[1]Contributed by E. L. Dakan, Department of Poultry Husbandry, Ohio State University.

rigid hammer-type hammer mills, one was the triple reduction process, or combination, hammer mill, and three were the swinging hammer-type hammer mills.

There were, therefore, five rather distinct types of feed mills: Burr, combination, triple reduction process, and rigid and swinging hammer types. Some of these mills were equipped with a speed-jack to raise the mill speed to the manufacturer's rating; others were belted directly to the power unit. Where no speed-jack is used, the R. P. M. of the mill is generally much less; however, the peripheral speed at the point of the hammers is about the same as that on a mill equipped with a speed-jack. This is accomplished by having a greater diameter. Most of the mills were of the larger type, running from 10 to 35 horsepower. The grains and roughages ground were oats, barley, shelled corn, ear corn, alfalfa, corn stover, and soybean hay. On each test of grains and roughages four runs were made, comprising: Full, three-quarter, one-half, and one-quarter capacity. Each of these runs was of from 2 to 7 minutes' duration. The mills were operated by men from the Agricultural Engineering Department.

In order to make all tests comparable, standards were set for fineness of grinding and moisture content of the materials to be ground. These standards are listed in Table 3.

TABLE 3.—Standards for Fineness of Grinding and Moisture Content

Material ground	Fineness Moduli	Moisture content
Oats	2.70	10.0
Barley	3.60	10.0
Shelled corn	3.90	12.0
Ear corn	3.00	12.0
Alfalfa	1.90	8.0
Soybean hay	3.00	12.0
Corn stover	3 20	13.0

Preliminary testing was done to adjust the mills to the proper degree of fineness. All testing for fineness was accomplished by the fineness modulus or index system adopted by the American Society of Agricultural Engineers.

It was not always possible to adjust the mills to grind exactly to the standard set for fineness; therefore, limits were set which allowed for a variation of one-tenth above or below the standard. In some cases on the hammer mills one screen would produce too fine a product and when the next larger screen was used the product

NOTE: The foregoing standards for fineness of grinding may not be entirely favorable to burr-mill operation—See Figures 31, 32, and 33.

would be too coarse. It was, therefore, necessary to regulate the speed of some of the hammer mills to arrive more closely at the desired fineness. Slower speed will produce coarser grinding, and higher speed finer grinding.

When the feeds were brought to the laboratory they were tested for moisture content. If the feeds were too high in moisture content, they were allowed to dry until the standard was reached; if too low in moisture content, the feeds were placed in a room with high humidity where the moisture could be taken up. A tolerance of one per cent was allowed for moisture content either above or below the standard. The mills were run at the manufacturers' rated R. P. M. unless it was found necessary to change the speed slightly to produce coarser or finer grinding. The rate of feeding was accomplished on grains by a variable feeder, which was built by the department. This device has a capacity of from 5 to 250 bushels per hour.

The full capacity tests were secured by increasing the rate of feeding until some determining factor showed up in the operation which limited more material being fed to the mill. Feeding was then decreased until the mill operated satisfactorily. The three-quarter, one-half, and one-quarter capacity tests were then figured from the full capacity tests. On roughage grinding the rate of feeding rested solely upon the judgment of the operator. The weight per bushel of grains was recorded. The room humidity was recorded but not controlled. In addition, the temperature of the materials after grinding was noted and the variation in this particular respect was surprising. If the mill is equipped with an exhaust fan its use may lower the temperature of the materials slightly.

BRIEF SPECIFICATIONS OF MILLS AS EQUIPPED FOR TEST

BURR MILLS

Name of mill	Diameter of burr	Rated mill speed in R. P. M.	Sacking elevator or exhaust fan
	Inch		
Letz No. 220	10½ or 10	850–1200	Sacking elevator
McCormick-Deering 10 in.—Type "D"	10	520–1000	Sacking elevator
McCormick-Deering 8 in.—Type "B"	8	500–1000	Sacking elevator
Stover No. 45	10	1000	Sacking elevator

COMBINATION MILLS

BURR-TYPE

Name of mill	Size of mill	Rated mill speed in R. P. M.	Sacking elevator or exhaust fan	Width of cutter head	Type of cutter head	Double or single shear	Type of feed
	Inch			*Inch*			
Letz No. 344	12 and 10½	750– 850	Exhaust fan	12	Cyl. type with spiral knives	Double	Force feed
Stover No. 69	10	600–1200	Sacking elevator	12	Cyl. type with spiral knives	Double	Force feed

HAMMER MILLS

Name of mill	Rated mill speed in R. P. M.	Belted directly or speed-jack	Type of speed-jack	Rotor diameter	Type of hammer tip	Fan mounting	Positive or gravity feed	Width of feed throat
RIGID-HAMMER-TYPE								
				Inch				*Inch*
Papec 27-B, 13-in.	2000–2400	Belted directly		26½	Removable tip	On independent shaft	Positive	13
Fairbanks-Morse	2000–4000	Speed-jack	Pulleys with flat belt	12	Split	On rotor shaft	Gravity	18
SWINGING-HAMMER-TYPE								
Hocking-Valley	3400	Speed-jack	Sheave pulleys and V-belts	22	Notched	On independent shaft	Gravity	15
Rowell No. 2	3600	Speed-jack	Pulleys with flat belt	16¼	Notched	On rotor shaft	Gravity	9½
Stover No. 90	3600	Speed-jack	Pulleys with flat belt		Notched	On independent shaft	Gravity	9
TRIPLE-REDUCTION-PROCESS-TYPE								
Bluestreak No. 20	1800	Belted directly		37½	Discs and plain	On independent shaft	Gravity	11

TEST DATA

Letz Mill No. 220

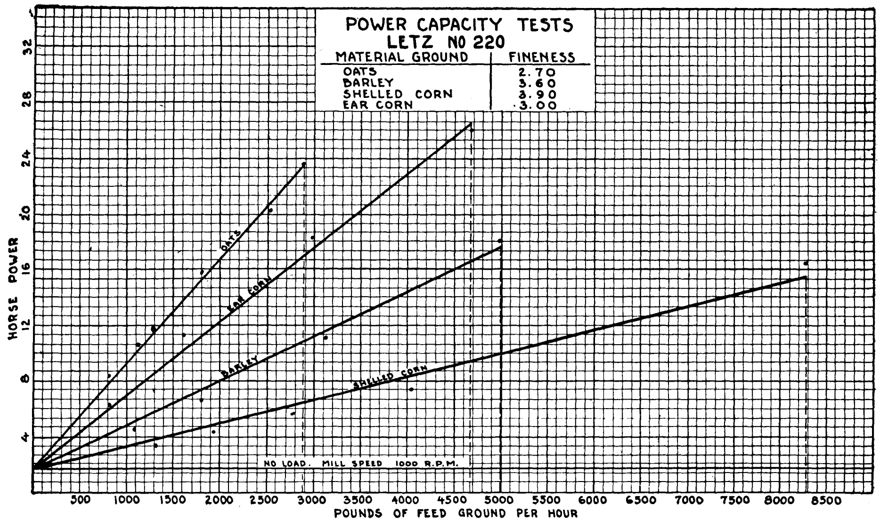
Test No.	Length of test (Min.)	Material ground	Test weight per bushel	Temperature of material (°F.)		Increase in Temp. (°F.)	Moisture content	Relative humidity (Room)	Grinding plates	Speeds R. P. M.		Horse-power at mill pulley		Pounds ground	Pounds per hour	Pounds per H. P. hour	Fineness modulus
				Before grinding	After grinding		Before grinding		C. M. or F.	Power unit	Mill	Mill empty	Mill under load				
1	3	Oats	33½	71	112	40	10.7	64	Medium	1000	*	1.8	23.7	144.0	2880	121	2.80
2	3	Oats	32½	71	100	29	10.7	64	Medium	1000	*	....	15.8	90.0	1800	114	2.79
3	3	Oats	32½	71	101	30	10.7	64	Medium	1000	*	....	11.8	64.5	1290	109	2.81
4	5	Oats	33	71	111	40	9.0	38	Medium	1000	*	....	10.5	93.25	1119	106	2.61
1A	5	Oats	33	70	107	37	9.0	36	Medium	1000	*	....	8.3	67.75	813	98	2.60
2A	5	Oats	33	70	116	46	9.0	36	Medium	980	*	....	20.2	210.0	2520	124	2.81
5	5	Barley	39.7	70	97	27	11.0	66	Medium	995	*	....	18.0	416.5	4998	278	3.66
6	5	Barley	39.7	70	90	20	11.0	66	Medium	1000	*	....	11.1	261.0	3132	282	3.57
7	5	Barley	39.7	70	87	17	11.0	66	Medium	1002	*	....	6.4	150.0	1800	281	3.51
8	5	Barley	39.7	70	86	16	11.0	66	Medium	996	*	....	4.4	91.0	1092	248	3.50
9A	5	Shelled corn	55.0	70	80	10	13.0	38	Coarse	1000	*	....	16.5	691.0	8292	503	3.97
9	5	Shelled corn	55.0	70	77	7	12.2	38	Coarse	1001	*	....	7.2	335.0	4020	556	3.96
10	5	Shelled corn	55.0	70	78	8	12.2	38	Coarse	1008	*	....	5.7	231.0	2772	486	3.96
11	5	Shelled corn	55.0	70	76	6	12.2	38	Coarse	1010	*	....	4.2	161.0	1932	460	3.97
12	5	Shelled corn	55.0	70	74	4	12.2	38	Coarse	1009	*	....	3.2	109.0	1308	409	3.83
13	5	Ear corn	....	70	....	....	12.9	40	Medium	1013	*	....	26.0	390.0	4680	180	3.10
14	5	Ear corn	....	70	83	13	12.9	40	Medium	1010	*	....	18.2	248.0	2976	164	3.11
15	5	Ear corn	....	70	91	21	12.9	40	Medium	986	*	....	11.2	134.0	1608	144	3.09
16	5	Ear corn	....	70	96	26	12.8	57	Medium	999	*	....	6.1	67.0	804	132	2.90

*Mill speed could not be obtained. Figured speed=Engine R. P. M.=1000. Mill R. P. M.=1000.

TEST DATA

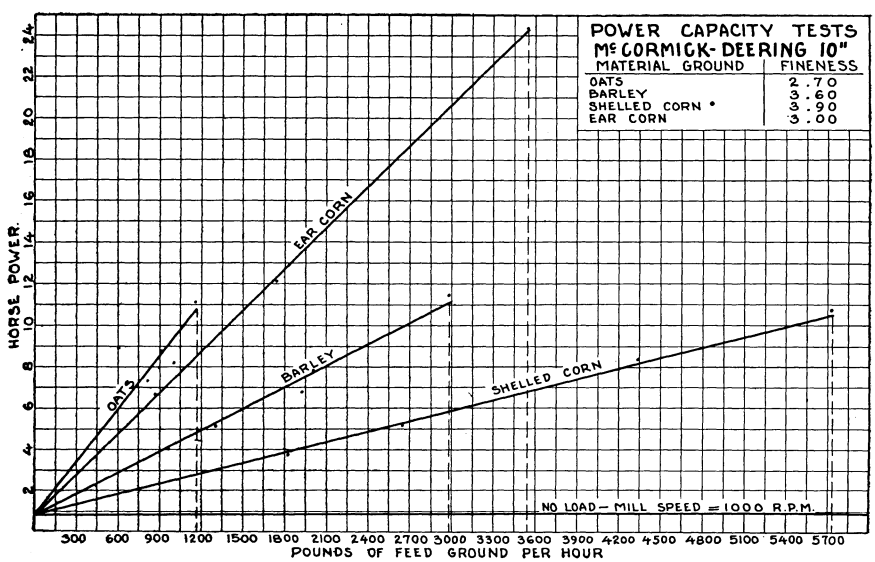
Burr Mill—McCormick-Deering-10″ Type D

Test No.	Length of test (Min.)	Material ground	Test weight per bushel	Temperature of material (°F.)		Increase in Temp. (°F.)	Moisture content	Relative humidity (Room)	Grinding plates	Speeds R. P. M.		Horse-power at mill pulley		Pounds ground	Pounds per hour	Pounds per H. P. hour	Fineness modulus
				Before grinding	After grinding		Before grinding		C. M. or F.	Power unit	Mill	Mill empty	Mill under load				
1	5	Oats	33	70	106	36	8.0	36	Medium	1000	1000	.86	11.11	96.0	1152	104	2.79
2	5	Oats	33	70	97	27	8.0	36	Medium	1000	998	....	8.7	77.0	924	106	2.76
3	5	Oats	33	70	96	26	8.0	36	Medium	995	1000	....	7.98	75.0	900	113	2.69
4	5	Oats	33	70	95	25	8.0	36	Medium	990	994	....	7.28	69.0	828	114	2.73
1-A	5	Oats	33	70	90	20	8.0	40	Medium	1000	1000	....	6.06	47.0	564	93	2.68
5	5	Barley	39.7	70	91	21	8.5	40	Medium	994	998	....	11.54	248.0	2976	258	3.60
6	5	Barley	39.7	70	86	16	8.5	40	Medium	988	990	....	6.73	161.5	1938	288	3.61
7	5	Barley	39.7	70	84	14	8.5	40	Medium	986	1000	....	5.06	109.0	1308	258	3.62
8	5	Barley	39.7	70	78	8	8.5	40	Medium	990	1005	....	4.06	80.0	960	236	3.64
9	5	Sh'd corn	52.0	70	85	15	11.0	42	Medium	1000	990	....	10.8	477.0	5724	530	3.88
10	5	Sh'd corn	52.0	70	86	16	11.0	42	Medium	990	990	....	5.3	221.0	2652	500	3.80
11	5	Sh'd corn	52.0	70	88	18	11.0	42	Medium	998	990	....	8.4	362.0	4344	517	3.83
12	5	Sh'd corn	52.0	70	89	19	11.0	42	Medium	985	990	....	3.7	153.0	1836	496	3.89
13	5	Ear corn	....	70	85	15	9.8	46	Medium	990	1000	....	6.6	72.7	872	132	3.16
14	5	Ear corn	....	70	96.5	26.5	9.8	44	Medium	1000	1005	....	24.27	294.5	3534	146	3.18
15	5	Ear corn	....	70	94	24	9.8	57	Medium	1000	1008	....	12.1	145.5	1746	144	3.00
16	5	Ear corn	....	70	91	21	9.8	57	Medium	998	996	....	8.2	83.0	996	121	2.94



POWER CAPACITY TESTS
LETZ NO 220
MATERIAL GROUND | FINENESS
OATS 2.70
BARLEY 3.60
SHELLED CORN 3.90
EAR CORN 3.00
OATS
EAR CORN
BARLEY
SHELLED CORN
NO LOAD. MILL SPEED 1000 R.P.M.
HORSE POWER
4 8 12 16 20 24 28 32
500 1000 1500 2000 2500 3000 3500 4000 4500 5000 5500 6000 6500 7000 7500 8000 8500
POUNDS OF FEED GROUND PER HOUR

Fig. 18



POWER CAPACITY TESTS
McCORMICK-DEERING 10"
MATERIAL GROUND | FINENESS
OATS 2.70
BARLEY 3.60
SHELLED CORN 3.90
EAR CORN 3.00
OATS
EAR CORN
BARLEY
SHELLED CORN
NO LOAD — MILL SPEED = 1000 R.P.M.
HORSE POWER.
2 4 6 8 10 12 14 16 18 20 22 24
300 600 900 1200 1500 1800 2100 2400 2700 3000 3300 3600 3900 4200 4500 4800 5100 5400 5700
POUNDS OF FEED GROUND PER HOUR

Fig. 19

TEST DATA

Burr Mill—McCormick-Deering-8″ Type B

Test No.	Length of test (Min.)	Material ground	Test weight per bushel	Temperature of material (°F.) Before grinding	Temperature of material (°F.) After grinding	Increase in Temp. (°F.)	Moisture content Before grinding	Relative humidity (Room)	Grinding plates C. M. or F.	Speeds R. P. M. Power unit	Speeds R. P. M. Mill	Horse-power at mill pulley Mill empty	Horse-power at mill pulley Mill under load	Pounds ground	Pounds per hour	Pounds per H. P. hour	Fineness modulus
1	5	Oats	33	70	120	50	10.8	40	Medium	1010	1004	1.0	11.63	75	900	77	2.73
2	5	Oats	33	70	122	52	10.8	40	Medium	1002	1000	....	10.60	70	840	79	2.77
3	5	Oats	33	70	121	51	10.8	38	Medium	995	1000	....	10.80	71	852	79	2.78
4	5	Oats	33	70	120	50	10.8	38	Medium	1010	1004	....	3.80	26	312	82	2.87
5	5	Barley	39.7	70	74	4	10.9	36	Medium	992	1010	....	4.85	166	1992	411	3.56
6	5	Barley	39.7	70	79	9	10.9	36	Medium	1006	1010	....	3.60	131	1572	437	3.75
7	5	Barley	39.7	70	78	8	10.9	36	Medium	1004	1010	....	2.95	100	1200	407	3.66
8	5	Barley	39.7	70	80	10	10.9	36	Medium	1012	1017	....	2.78	90	1080	388	3.69
9	5	Shelled corn	55	70	76.5	6.5	11.3	40	Medium	1012	1014	....	7.8	304	3648	468	3.99
10	5	Shelled corn	55	70	75.5	5.5	11.3	40	Medium	998	1004	....	5.7	256	3072	539	3.81
11	5	Shelled corn	55	70	71	1	11.3	40	Medium	1004	1006	....	4.0	154.5	1854	464	3.83
12	5	Shelled corn	55	70	70	....	11.3	38	Medium	1006	1010	....	3.1	120	1440	465	3.89
13	5	Ear corn	....	70	84	14	12.7	32	Medium	1020	1006	....	9.1	190.5	2286	251	3.02
14	5	Ear corn	....	70	84	14	12.7	32	Medium	1005	1000	....	8.2	161.5	1938	236	3.07
15	5	Ear corn	....	70	82	12	12.7	32	Medium	1010	1000	....	6.02	102	1224	203	3.09
16	5	Ear corn	....	70	77	7	12.7	32	Medium	1018	1006	....	4.00	56.5	678	164	3.07

TEST DATA

Burr Mill—Stover No. 45

Test No.	Length of test (Min.)	Material ground	Test weight per bushel	Temperature of material (°F.) Before grinding	Temperature of material (°F.) After grinding	Increase in Temp. (°F.)	Moisture content Before grinding	Relative humidity (Room)	Grinding plates C. M. or F.	Speeds R. P. M. Power unit	Speeds R. P. M. Mill	Horse-power at mill pulley Mill empty	Horse-power at mill pulley Mill under load	Pounds ground	Pounds per hour	Pounds per H. P. hour	Fineness modulus
1	5	Oats	33	70	137	67	10.8	32	Fine	850	1000	3.4	30.1	136.0	1632	54	2.80
2	3	Oats	33	70	147	77	10.8	32	Fine	830	1000	....	21.0	49.0	980	47	2.68
3	3	Oats	33	70	144	74	10.8	32	Fine	830	1000	....	23.5	52.0	1040	44	2.65
4	3	Oats	33	70	144	74	10.8	32	Fine	835	1000	....	18.6	42.5	850	46	2.60
5	4	Barley	41	70	83	13	10.1	45	Medium	880	1000	....	17.6	464.0	6960	395	3.50
6	3	Barley	41	70	75	5	10.1	45	Medium	860	1000	....	11.3	202.0	4040	357	3.71
7	3	Barley	41	71	76	5	10.1	45	Medium	850	1005	....	9.5	123.5	2470	266	3.59
8	3	Barley	41	71	83	13	10.1	45	Medium	850	1005	....	7.9	89.0	1780	225	3.54
9	5	Shelled corn	51	70	82	12	11.1	44	Coarse	860	1000	....	15.4	840.0	10080	655	4.10
10	3	Shelled corn	51	70	82	12	11.1	44	Coarse	840	1000	....	9.2	279.5	5590	607	3.99
11	3	Shelled corn	51	70	82	12	11.1	44	Coarse	840	998	....	7.5	177.5	3550	475	3.89
12	3	Shelled corn	51	70	83	13	11.1	44	Coarse	830	1000	....	5.7	123.5	2470	433	3.80
13	3	Ear corn	....	70	81	11	10.9	31	Medium	870	1000	....	29.8	364.0	7280	244	3.10
14	3	Ear corn	....	70	77	7	10.9	31	Medium	850	1000	....	26.1	302.0	6040	231	3.11
15	3	Ear corn	....	70	83	13	10.9	31	Medium	840	1000	....	22.2	230.5	4610	208	3.09
16	3	Ear corn	....	70	94	24	10.9	31	Medium	840	1000	....	13.0	112.0	2240	172	3.08

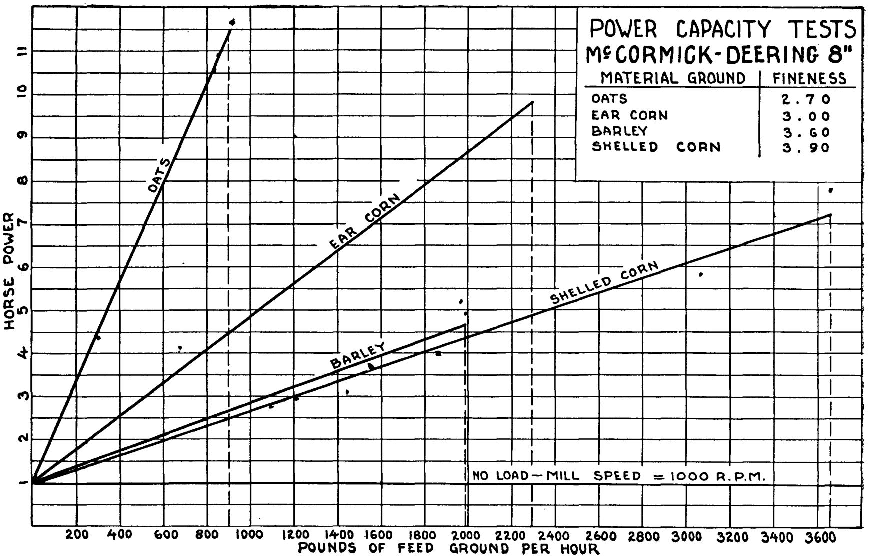

POWER CAPACITY TESTS
McCORMICK-DEERING 8"
MATERIAL GROUND | FINENESS
OATS 2.70
EAR CORN 3.00
BARLEY 3.60
SHELLED CORN 3.90
OATS
EAR CORN
SHELLED CORN
BARLEY
NO LOAD—MILL SPEED = 1000 R.P.M.
HORSE POWER
1 2 3 4 5 6 7 8 9 10 11
200 400 600 800 1000 1200 1400 1600 1800 2000 2200 2400 2600 2800 3000 3200 3400 3600
POUNDS OF FEED GROUND PER HOUR

Fig. 20

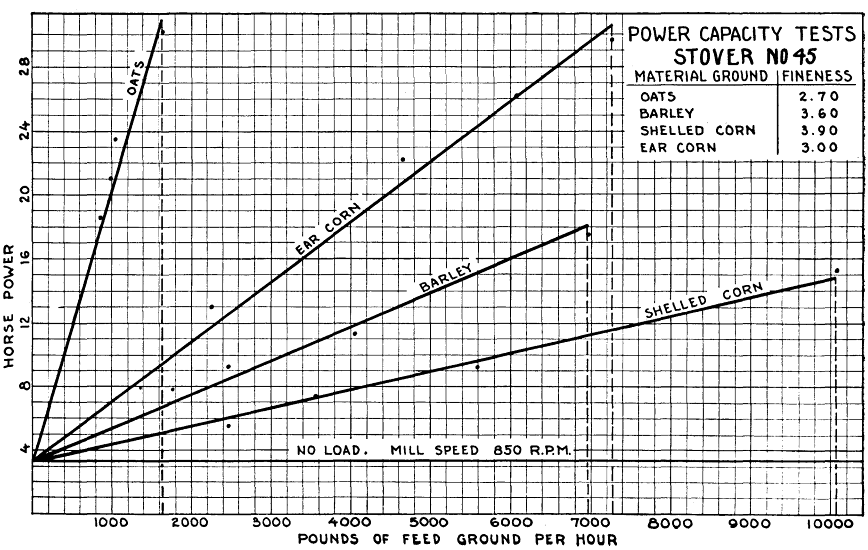

POWER CAPACITY TESTS
STOVER NO 45
MATERIAL GROUND | FINENESS
OATS 2.70
BARLEY 3.60
SHELLED CORN 3.90
EAR CORN 3.00
OATS
EAR CORN
BARLEY
SHELLED CORN
NO LOAD. MILL SPEED 850 R.P.M.
HORSE POWER
4 8 12 16 20 24 28
1000 2000 3000 4000 5000 6000 7000 8000 9000 10000
POUNDS OF FEED GROUND PER HOUR

Fig. 21

TEST DATA

Letz Mill—No. 344. Combination Mill—Burr Type

Test No.	Length of test (Min.)	Material ground	Temperature of material (°F.)		Increase in Temp. (°F.)	Moisture content	Relative humidity (Room)	Screen number or name (In.)	Grinding plates	Speeds R. P. M.		Horse-power at mill pulley		Pounds ground	Pounds per hour	Pounds per H. P. hour	Fineness modulus	Length of cut (In.)
			Before grinding	After grinding		Before grinding			C. M. or F.	Power unit	Mill	Mill empty	Mill under load					
13	5	Ear corn	70	76	6	12.4	57	3/4	Coarse D-214/12 in.	1010	850	3.6	35.8	530	6360	177	3.12	3/16
14	4	Ear corn	70	75	5	12.4	57	3/4	Coarse D-214/12 in.	1000	840	....	21.3	219	3285	155	3.10	3/16
15	4	Ear corn	70	76	6	12.4	57	3/4	Coarse D-214/12 in.	1010	840	....	27.0	316	4740	175	3.02	3/16
16	4	Ear corn	70	76	6	12.4	48	3/4	Coarse D-214/12 in.	980	850	....	13.2	127	1905	144	3.05	3/16
17-A	4	Alfalfa	70	85	15	7	42	5/16	Fine B-34/10½ in.	1020	840	....	29.7	98	1470	49	1.88	1/8
18	3	Alfalfa	70	80	10	7	42	5/16	Fine B-34/10½ in.	1020	840	....	28.6	66	1320	46	2.00	1/8
19	3	Alfalfa	70	78	8	7	42	5/16	Fine B-34/10½ in.	1020	845	....	22.3	45½	910	41	2.05	1/8
20	3	Alfalfa	70	78	8	7	42	5/16	Fine B-34/10½ in.	999	850	....	14.2	22	440	31	2.08	1/8
21	3	Soybean hay	70	74	4	13	36	3/4	Coarse D-214/12 in.	1025	850	....	29.2	152½	3050	105	3.05	3/16
22	3	Soybean hay	70	75	5	13	36	3/4	Coarse D-214/12 in.	1000	840	....	28.8	139	2780	97	3.00	3/16
23	3	Soybean hay	70	74	4	13	36	3/4	Coarse D-214/12 in.	990	840	....	20.4	102½	2050	100	2.93	3/16
24	3	Soybean hay	70	74	4	13	36	3/4	Coarse D-214/12 in.	980	840	....	18.1	79	1580	87	3.00	3/16
25	4	Corn stover*	70	70	0	12.8	60	3/4	Coarse DA-214/12 in.	980	840	....	22.4	181	2715	121	3.30	3/16
26	4	Corn stover	70	70	0	12.8	60	3/4	Coarse DA-214/12 in.	970	840	....	21.5	148	2220	103	3.31	3/16
27	3	Corn stover	70	70	0	12.8	57	3/4	Coarse DA-214/12 in.	975	842	....	15.3	74	1480	97	3.40	3/16
28	3	Corn stover	70	70	0	12.8	57	3/4	Coarse DA-214/12 in.	970	840	....	11.2	43	860	77	3.30	3/16
13-A	3	Ear corn	70	No temp. taken		12.4	57	3/4	Coarse D-214/12 in.	1020	840	....	36.6	631	12620	345	4.14	3/16
17	4	Alfalfa	70	80	10	7	42	5/16	Very fine B-35	1025	845	....	27.2	27½	413	165	1.75	1/8
17-B	2	Alfalfa	No temperature taken			7	42	3/4	Coarse D-214/12 in.	1025	880	....	13.4	96½	2895	216	3.09	3/16
25-A	4	Corn stover	No temperature taken			12.8	57	3/4	Coarse D-214/12 in.	990	840	....	27.1	222	3330	123	3.89	3/16

*No ears on corn stover.

TEST DATA

Combination Mill, Burr Type—Stover No. 69

Test No.	Length of test (Min.)	Material ground	Temperature of material (°F.)		Increase in Temp. (°F.)	Moisture content	Rela-tive humid-ity (Room)	Grinding plates	Speeds R. P. M.		Horse-power at mill pulley		Pounds ground	Pounds per hour	Pounds per H. P. hour	Fineness modulus
			Before grind-ing	After grind-ing		Before grind-ing		C. M. or F.	Power unit	Mill	Mill empty	Mill under load				
13	3	Ear corn	70	89	19	11.5	53	Medium	850	1000	1.6	34.2	248½	4970	145	3.10
14	3	Ear corn	70	89	19	11.5	53	Medium	850	1000	....	32.4	241	4820	149	3.11
15	3	Ear corn	70	93	23	11.5	53	Medium	870	1000	....	26.4	184	3680	139	2.97
16	3	Ear corn	70	92	22	11.5	53	Medium	875	1000	....	15.8	98½	1970	125	3.00
17	4	Alfalfa	70	137	67	7.4	40	Fine	800	980	....	27 0	38	570	21	2.00
18	3	Alfalfa	70	146	76	7.4	40	Fine	870	1000	....	31.2	39½	790	25	2.01
19	3	Alfalfa	70	150	80	7.4	40	Fine	980	1000	....	33.6	42	840	25	1.98
20	3	Alfalfa	70	143	73	7.4	40	Fine	870	1000	....	23.6	24	480	20	1.97
21	4	Soybean hay	70	97	27	11.0	36	Medium	880	1000	....	24.8	117½	1763	71	2.95
22	4	Soybean hay	70	96	26	11.0	36	Medium	870	1000	....	19.0	93½	1403	74	2.94
23	4	Soybean hay	70	103	33	11.0	36	Medium	840	1000	....	15.6	75½	1133	73	2.94
24	4	Soybean hay	70	105	35	11.0	36	Medium	820	1000	....	14.6	69	1035	71	2.91
25	4	Corn stover	70	120	50	12.1	48	Coarse	860	1000	....	20.2	47	705	35	3.35
26	4	Corn stover	70	134	64	12.1	48	Coarse	840	1000	....	19.2	41	615	32	3.26
27	4	Corn stover	70	137	64	12.1	48	Coarse	820	1000	....	14.4	29	435	30	3.27
28	4	Corn stover	70	127	57	12.1	48	Coarse	820	1000	....	12.6	27	405	32	3.14

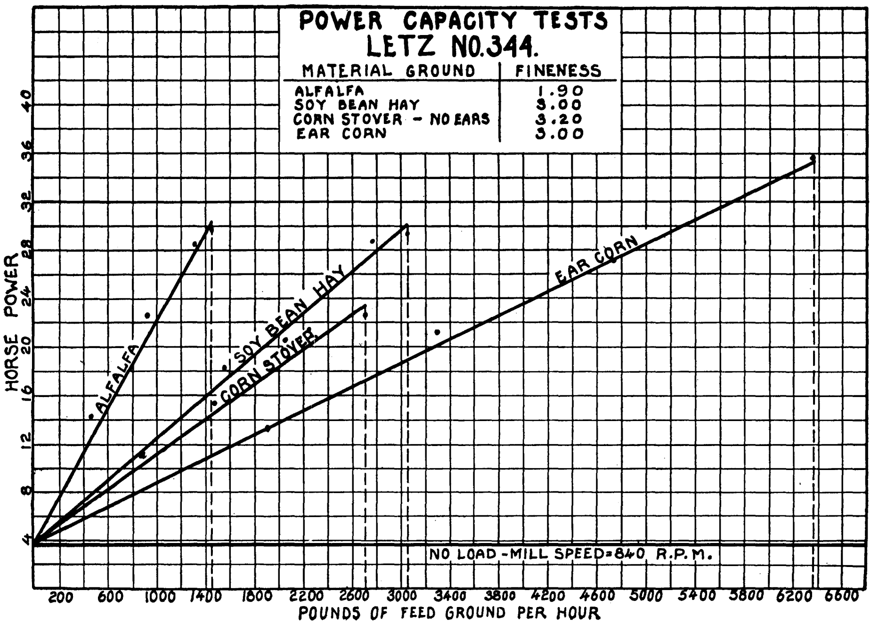

POWER CAPACITY TESTS
LETZ NO.344.
MATERIAL GROUND
FINENESS
ALFALFA 1.90
SOY BEAN HAY 3.00
CORN STOVER - NO EARS 3.20
EAR CORN 3.00
ALFALFA
SOY BEAN HAY
CORN STOVER
EAR CORN
NO LOAD - MILL SPEED = 840 R.P.M.
HORSE POWER
4 8 12 16 20 24 28 32 36 40
200 600 1000 1400 1800 2200 2600 3000 3400 3800 4200 4600 5000 5400 5800 6200 6600
POUNDS OF FEED GROUND PER HOUR

Fig. 22

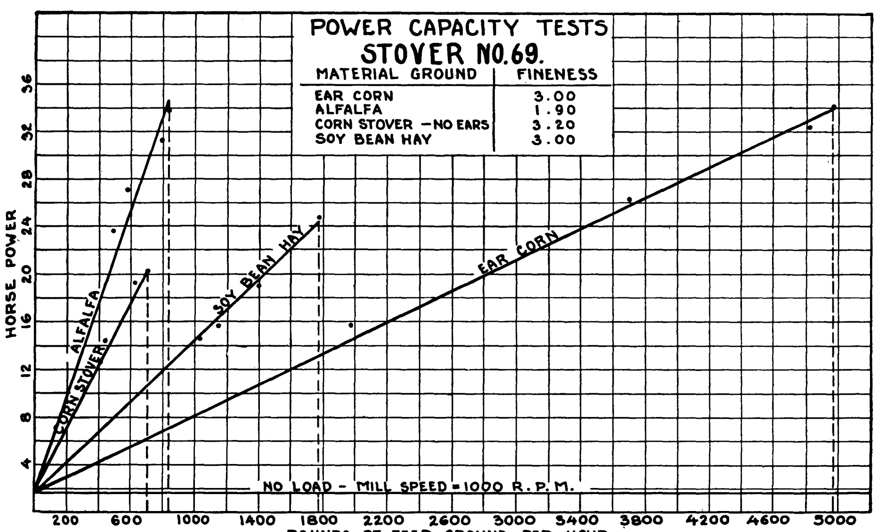

POWER CAPACITY TESTS
STOVER NO.69.
MATERIAL GROUND
FINENESS
EAR CORN 3.00
ALFALFA 1.90
CORN STOVER - NO EARS 3.20
SOY BEAN HAY 3.00
ALFALFA
CORN STOVER
SOY BEAN HAY
EAR CORN
NO LOAD - MILL SPEED = 1000 R.P.M.
HORSE POWER
4 8 12 16 20 24 28 32 36
200 600 1000 1400 1800 2200 2600 3000 3400 3800 4200 4600 5000
POUNDS OF FEED GROUND PER HOUR

Fig. 23

TEST DATA

Hammer Mill—Papec 27-B, 13-in.

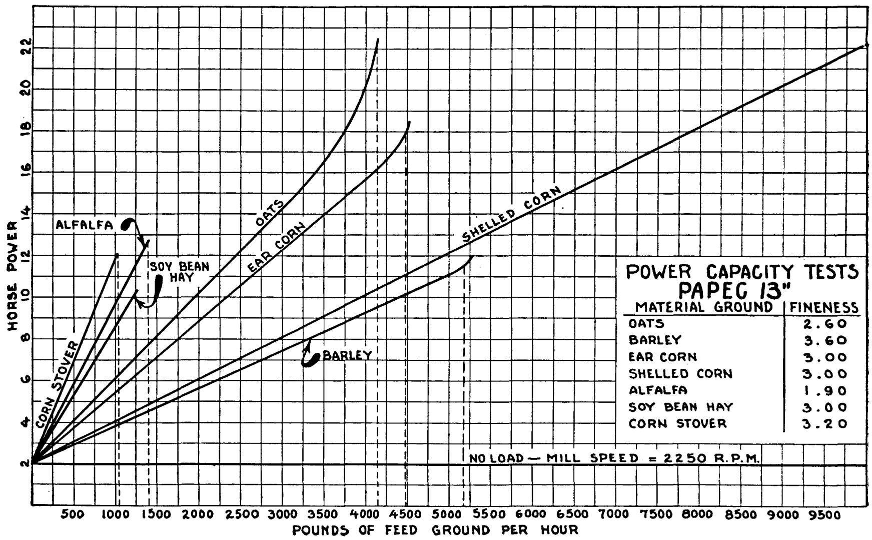
Test No.	Length of test (Min.)	Material ground	Test weight per bushel	Temperature of material (°F.) Before grinding	Temperature of material (°F.) After grinding	Increase in Temp. (°F.)	Moisture content Before grinding	Relative humidity (Room)	Screen number or name (In.)	Speeds R. P. M. Power unit	Speeds R. P. M. Mill	Horse-power at mill pulley Mill empty	Horse-power at mill pulley Mill under load	Pounds ground	Pounds per hour	Pounds per H. P. hour	Fineness modulus
1	5	Oats	32	70	88	18	12.0	59	5/16	1140	2180	2.0	22.4	342	4104	183	2.70
2	5	Oats	32	70	87	17	12.0	59	5/16	1140	2180	....	10.7	181	2172	203	2.76
3	5	Oats	32	70	85	15	12.0	59	5/16	1135	2180	....	8.4	127	1524	181	2.80
4	5	Oats	32	70	82	12	12.0	59	5/16	1125	2180	....	6.3	83	996	158	2.87
5	3	Barley	42	70	77	7	11.8	44	5/8	1025	1960	....	11.5	259	5180	450	3.65
6	3	Barley	42	70	76	6	11.8	44	5/8	1022	1960	....	8.2	170	3400	415	3.63
7	5	Barley	42	70	74	4	11.8	44	5/8	1020	1960	....	6.3	196	2352	373	3.66
8	5	Barley	42	70	75	5	11.8	44	5/8	1020	1960	....	5.3	149	1788	337	3.57
9	3	Shelled corn	53	70	92	22	9.6	36	3/4	1090	2000	....	23.5	536	10720	456	3.13
10	3	Shelled corn	53	70	78	8	7.8	55	3/4	1058	2000	....	11.5	232	4640	403	2.93
11	5	Shelled corn	53	70	80	10	7.8	55	3/4	1045	2000	....	8.6	267	3204	372	3.07
12	5	Shelled corn	53	70	80	10	7.8	55	3/4	1030	1980	....	8.9	196	2352	341	2.94
13	8	Ear corn	....	69	78	9	12.7	42	5/8	1220	2320	....	18.1	594	4455	246	3.17
14	5	Ear corn	....	70	77	7	12.7	42	5/8	1225	2320	....	12.9	270	3240	251	2.95
15	5	Ear corn	....	69	76	7	12.7	42	5/8	1230	2330	....	10.1	194	2328	232	2.97
16	5	Ear corn	....	69	76	7	12.7	42	5/8	1220	2320	....	9.2	170	2040	216	2.94
17	5	Alfalfa	....	71	78	7	7.0	42	3/16	1230	2330	....	12.0	119.5	1434	119	1.85
18	5	Alfalfa	....	71	78	7	7.0	42	3/16	1236	2330	....	9.2	74	888	96	1.82
19	5	Alfalfa	....	71	79.5	8.5	7.0	42	3/16	1240	2330	....	6.5	40	480	70	1.79
18A	3	*Alfalfa	....	70	93	13	7.5	48	3/16	1180	2280	....	4.5	15.5	310	33	2.00
21	3	*Soybean hay	....	70	90	20	12.8	48	3/4	1130	2100	....	9.9	63.5	1270	128	2.95
22	4	*Soybean hay	....	70	89	19	12.8	48	3/4	1100	2090	....	8.4	70	1050	120	2.94
23	3	*Soybean hay	....	70	89	19	12.8	48	3/4	1110	2100	....	7.2	48	720	100	2.85
24	3	*Soybean hay	....	70	87	17	12.8	48	3/4	1105	2105	....	5.8	24	480	83	2.96
25A	3	*Corn stover	....	70	92	22	13.2	48	3/4	1120	2100	....	12.0	51	1020	87	3.12
26A	3	*Corn stover	....	70	92	22	13.2	48	3/4	1118	2100	....	8.4	32	640	76	3.11
27	5	Corn stover	....	70	87	17	14.4	53	3/4	1040	2000	....	10.2	64	768	75	3.38
28	5	Corn stover	....	70	78	8	14.4	53	3/4	1040	2000	....	8.4	51	612	73	3.28
......	....	Shelled corn	Maximum coarseness						1	....	2200	....	....	....	....	....	3.10

*Run with spring above upper feed roller.

TEST DATA

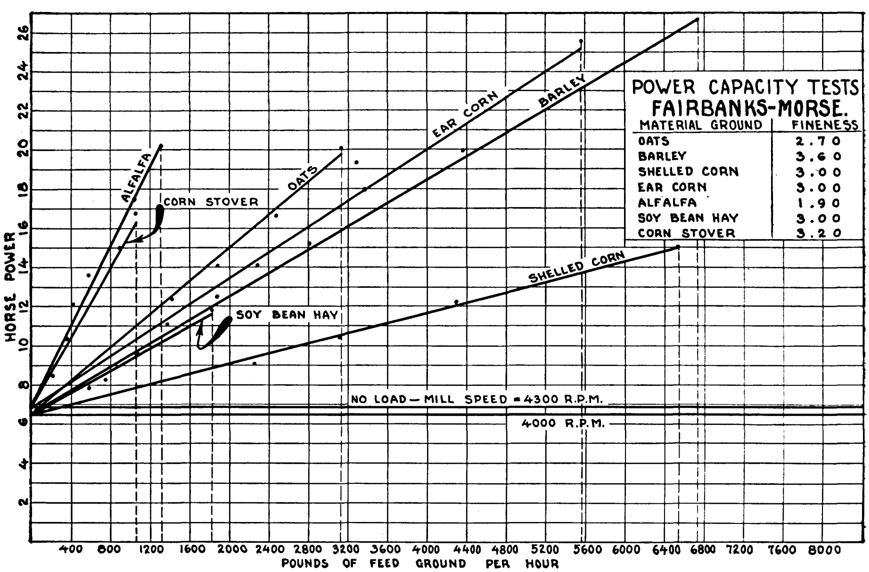
Hammer Mill—Fairbanks-Morse

Test No.	Length of test (Min.)	Material ground	Test weight per bushel	Temperature of material (°F.)		Increase in Temp. (°F.)	Moisture content	Relative humidity (Room)	Screen number or name (In.)	Speeds R. P. M.		Horse-power of mill pulley		Pounds ground	Pounds per hour	Pounds per H.P. hour	Fineness modulus
				Before grinding	After grinding		Before grinding			Power unit	Mill	Mill empty	Mill under load				
1	5	Oats	32	70	78	8	10.4	40	3/16	970	3984	6.5	20.1	261	3132	156	2.78
2	5	Oats	32	70	75	5	10.4	40	3/16	970	3937	....	16.6	207	2484	150	2.68
3	5	Oats	32	70	75	5	10.4	40	3/16	978	4010	....	14.0	158	1896	135	2.85
4	3	Oats	32	70	74	4	10.4	40	3/16	965	4000	....	12.4	119	1429	115	2.78
5	3	Barley	41	71	72	1	9.9	31	5/16	1015	4140	....	26.6	337	6740	253	3.70
6	5	Barley	41	71	72	1	9.9	31	5/16	1010	4178	....	20.0	218	4360	218	3.63
7	5	Barley	41	71	71	0	9.9	31	5/16	1005	4180	....	15.2	234½	2814	185	3.71
8	5	Barley	41	71	72	1	9.9	31	5/16	1000	4198	....	12.5	156½	1878	150	3.64
9	5	Shelled corn	52	70	76	6	11.3	38	3/4	960	4008	....	15.0	544½	6534	430	3.10
10	5	Shelled corn	52	70	77	7	11.3	38	3/4	970	4080	....	12.2	358	4296	352	3.06
11	5	Shelled corn	52	70	77	7	11.3	38	3/4	960	4012	....	10.4	260	3120	300	3.10
12	5	Shelled corn	52	70	77	7	11.3	38	3/4	950	3998	....	9.0	188	2256	251	3.09
13	5	Ear corn	....	70	77	7	11.8	40	7/16	1020	4188	....	25.6	463	5556	217	3.00
14	5	Ear corn	....	70	76	6	11.8	40	7/16	1010	4180	....	17.9	281½	3378	189	3.03
15	5	Ear corn	....	70	77	7	11.8	40	7/16	1005	4186	....	14.0	192½	2310	165	3.04
16A	5	Ear corn	....	70	76	6	11.8	40	7/16	1000	4100	....	11.0	115½	1386	126	2.99
17	5	Alfalfa	....	70	78	8	7.1	40	3/32	1100	4380	....	20.2	111	1332	66	2.00
18	5	Alfalfa	....	70	76	6	7.1	40	3/32	1040	4378	....	17.5	85½	1026	59	1.88
19	5	Alfalfa	....	70	75	5	7.1	38	3/32	1060	4420	....	13.6	49	588	43	1.92
20	5	Alfalfa	....	70	75	5	7.1	38	3/32	1050	4390	....	12.0	35	420	35	2.01
21	5	Soybean hay	....	70	71	1	11.7	38	9/16	980	3984	....	11.8	152½	1830	155	3.10
22	5	Soybean hay	....	70	71	1	11.7	38	9/16	1000	4085	....	9.6	89	1068	111	3.11
23	5	Soybean hay	....	70	72	2	11.7	38	9/16	980	4058	....	8.2	63	756	92	3.12
24	5	Soybean hay	....	70	73	3	11.7	38	9/16	980	4060	....	7.8	49	588	74	3.09
25	5	Corn stover	....	70	77	7	13.4	38	7/16	1040	4216	....	16.8	88½	1062	63	3.22
26	5	Corn stover	....	70	76	6	13.4	38	7/16	1020	4220	....	14.9	74	888	59	3.14
27	5	Corn stover	....	70	77	7	13.4	38	7/16	1010	4260	....	10.4	29	348	33	3.24
28	5	Corn stover	....	70	77	7	13.4	38	7/16	1010	4264	....	8.4	18½	222	26	3.30
9A	4	Shelled corn	52	....	....	....	11.3	38	11/16	920	3890	....	13.4	431	6465	482	3.13
......	....	Shelled corn	Maximum coarseness						2	....	3350	....	....	....	....	....	3.25



POWER CAPACITY TESTS
PAPEC 13"
MATERIAL GROUND | FINENESS
OATS 2.60
BARLEY 3.60
EAR CORN 3.00
SHELLED CORN 3.00
ALFALFA 1.90
SOY BEAN HAY 3.00
CORN STOVER 3.20
ALFALFA
SOY BEAN HAY
CORN STOVER
OATS
EAR CORN
SHELLED CORN
BARLEY
NO LOAD — MILL SPEED = 2250 R.P.M.
HORSE POWER
POUNDS OF FEED GROUND PER HOUR

Fig. 24



POWER CAPACITY TESTS
FAIRBANKS-MORSE.
MATERIAL GROUND | FINENESS
OATS 2.70
BARLEY 3.60
SHELLED CORN 3.00
EAR CORN 3.00
ALFALFA 1.90
SOY BEAN HAY 3.00
CORN STOVER 3.20
ALFALFA
CORN STOVER
OATS
EAR CORN
BARLEY
SOY BEAN HAY
SHELLED CORN
NO LOAD — MILL SPEED = 4300 R.P.M.
4000 R.P.M.
HORSE POWER
POUNDS OF FEED GROUND PER HOUR

Fig. 25

TEST DATA

Hammer Mill—Hocking Valley

Test No.	Length of test (Min.)	Material ground	Test weight per bushel	Temperature of material (°F.) Before grinding	Temperature of material (°F.) After grinding	Increase in Temp. (°F.)	Moisture content Before grinding	Relative humidity (Room)	Screen number or name (In.)	Speeds R. P. M. Power unit	Speeds R. P. M. Mill	Horse-power at mill pulley Mill empty	Horse-power at mill pulley Mill under load	Pounds ground	Pounds per hour	Pounds per H. P. hour	Fineness modulus
1	3	Oats	31.5	70	93	23	10.4	53	1/4	985	3250	9.6	32.5	247½	4950	152	2.78
2	4	Oats	31.5	72	93	21	10.4	48	1/4	980	3260	....	28.3	282	4230	149	2.77
3	5	Oats	31.5	72	90	18	10.4	48	1/4	980	3300	....	22.1	246	2952	134	2.70
4	5	Oats	31.5	72	88	16	10.4	48	1/4	965	3200	....	17.4	137	1644	94	2.86
5	3	Barley	40.8	70	76	6	9.2	53	3/4	975	3200	....	24.4	396½	7930	325	3.63
6	....	Not sufficient quantity of barley			....	....	....	....	....	....	....	....	....	....	....	....	....
7	4	Barley	40.8	70	78	8	9.2	53	3/4	970	3270	....	16.2	211	3165	195	3.63
8	3	Barley	40.8	70	78	8	9.2	53	3/4	960	3230	....	13.4	100	2000	149	3.50
9	3	Shelled corn	52.0	70	82	12	11.2	53	3/4	930	3028	....	28.4	610	12200	430	3.11
10	3	Shelled corn	52.0	70	80	10	11.2	53	3/4	920	3030	....	20.4	342½	6850	336	3.08
11	5	Shelled corn	52.0	70	78	8	11.2	53	3/4	905	2980	....	16.2	356½	4278	264	2.89
12	5	Shelled corn	52.0	70	79	9	11.2	53	3/4	905	3036	....	13.1	219½	2634	201	2.96
13	4	Ear corn	....	72	88	16	9.9	48	9/16	1100	3300	....	35.4	602	9030	255	3.09
14	5	Ear corn	....	72	88	16	9.9	48	9/16	1090	3300	....	24.4	422	5064	208	3.08
15	5	Ear corn	....	72	90	18	9.9	48	9/16	950	3230	....	19.3	275	3300	171	3.08
16	5	Ear corn	....	72	92	20	9.9	48	9/16	955	3312	....	14.1	103½	1242	88	3.06
17	7	Alfalfa	....	70	78	8	9.1	46	5/32	1085	3480	....	13.0	51	438	34	1.65
18	5	Alfalfa	....	70	78	8	9.1	46	5/32	1080	3300	....	17.2	75	900	52	1.68
19	5	Alfalfa	....	70	78	8	9.1	55	5/32	1020	3270	....	18.8	89½	1070	57	1.82
*20	2	Alfalfa	....	70	85	15	9.5	54	5/32	1000	3200	....	26.4	55	1650	63	2.02
21	4	Soybean hay	....	70	78	8	13.2	55	9/16	1025	3270	....	15.5	98½	1478	95	2.96
22	5	Soybean hay	....	70	73	3	13.2	55	9/16	1015	3260	....	13.2	66	792	60	2.89
*23	2	Soybean hay	....	70	83	13	12.9	54	9/16	1015	3200	....	23.2	107	3210	138	2.89
24	....	Did not have sufficient quantity of hay				....	....	....	....	....	....	....	....	....	....	....	....
25	....	Corn stover	....	Error in Torque curve			....	....	....	....	....	....	....	....	....	....	....
*26	2	Corn stover	....	70	81	11	13.0	54	9/16	1000	3250	....	21.7	51	1530	71	3.20
*27	2	Corn stover	....	70	82	12	13.0	54	9/16	995	2952	....	25.7	64	1920	75	3.30
*28	4	Corn stover	....	70	81	11	13.0	54	9/16	995	3108	....	20.3	92	1380	68	3.21
......	....	Shelled corn	Maximum coarseness						3/4	....	3200	....	....	....	....	....	3.21

*Run with restricting bar out of mill.

TEST DATA

Hammer Mill—Rowell No. 2

Test No.	Length of test (Min.)	Material ground	Test weight per bushel	Temperature of material (°F.)		Increase in Temp. (°F.)	Moisture content	Relative humidity (Room)	Screen number or name (In.)	Speeds R. P. M.		Horse-power at mill pulley		Pounds ground	Pounds per hour	Pounds per H. P. hour	Fineness modulus
				Before grinding	After grinding		Before grinding			Power unit	Mill	Mill empty	Mill under load				
1	4	Oats	32	70	90	20	9.8	38	3/16	1020	3494	4.4	39.5	204	3060	78	2.67
2	3	Oats	32	70	82	12	9.8	38	3/16	1015	3480	....	22.8	112	2240	98	2.68
3	3	Oats	32	70	80	10	9.8	38	3/16	1015	3488	....	18.5	91	1820	98	2.76
4	3	Oats	32	70	80	10	9.8	38	3/16	1010	3500	....	14.4	67	1340	93	2.61
5	3	Barley	41	70	81	11	9.1	36	5/16	1025	3558	....	22.9	236½	4630	207	3.67
6	2	Barley	41	70	78	8	9.1	36	5/16	1015	3496	....	15.5	98	2940	190	3.61
7	2	Barley	41	70	77	7	9.1	36	5/16	1010	3520	....	13.1	69½	2085	159	3.53
8	3	Barley	41	70	76	6	9.1	36	5/16	1010	3474	....	12.0	88	1760	147	3.60
9	3	Shelled corn	51	70	79	9	11.2	36	3/4	1120	3854	....	19.3	311	6220	322	3.13
10	3	Shelled corn	51	70	77	7	11.2	36	3/4	1100	3790	....	15.6	209	4180	268	2.95
11	3	Shelled corn	51	70	76	6	11.2	36	3/4	1090	3770	....	12.5	155	3100	248	2.88
12	3	Shelled corn	51	70	76	6	11.2	36	3/4	1085	3760	....	11.0	110	2200	200	2.91
13	3	Ear corn	....	70	83	13	11.3	40	1/4	1100	3734	....	36.1	180	3600	99	3.05
14	3	Ear corn	....	70	83	13	11.3	40	1/4	1080	3738	....	30.3	150	3000	99	2.91
15	3	Ear corn	....	70	83	13	11.3	40	1/4	1060	3750	....	24.2	109	2180	90	2.93
16	3	Ear corn	....	70	81	11	11.3	40	1/4	1055	3720	....	19.0	78½	1570	83	2.97
17	3	Alfalfa	....	70	78	8	7.6	53	3/32	1100	3700	....	14.8	32	640	43	2.01
18	3	Alfalfa	....	70	78	8	7.6	53	3/32	1100	3682	....	13.1	27½	550	42	2.00
19	3	Alfalfa	....	70	77	7	7.6	53	3/32	1090	3706	....	9.4	16	320	34	2.00
20	3	Alfalfa	....	70	77	7	7.6	53	3/32	1080	3610	....	8.9	12	240	27	2.01
21	3	Soybean hay	....	70	81	11	11.8	40	3/4	1060	3700	....	11.4	55	1100	96	3.05
22	3	Soybean hay	....	70	78	8	11.8	40	3/4	1080	3650	....	11.0	53	1060	96	2.90
23	3	Soybean hay	....	70	75	5	11.8	40	3/4	1040	3664	....	8.8	31	620	70	2.90
24	2½	Soybean hay	....	70	74	4	11.8	40	3/4	1040	3618	....	9.8	38	912	93	3.10
25	3	Corn stover	....	70	80	10	12.1	53	1/2	1090	3500	....	10.8	29½	590	55	3.23
26	3	Corn stover	....	70	80	10	12.1	53	1/2	1060	3470	....	15.8	45½	910	57	3.28
27	3	Corn stover	....	70	81	11	12.1	53	1/2	1050	3562	....	14.0	41	820	59	3.30
28	3	Corn stover	....	70	79	9	12.1	53	1/2	1020	3520	....	9.0	20½	410	46	3.13
......	....	Shelled corn	Maximum coarseness....................................						....	....	3300	....	....	....	....	....	3.55

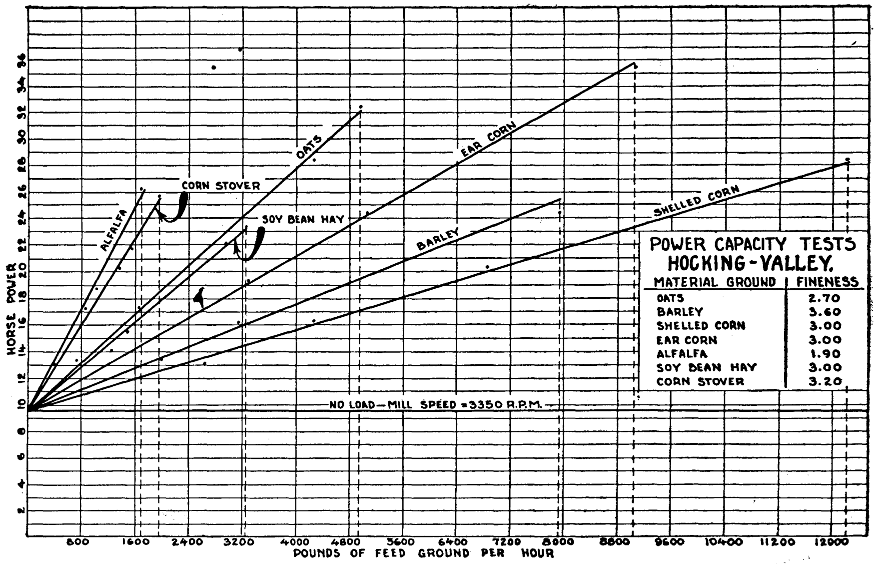

POWER CAPACITY TESTS
HOCKING-VALLEY.
MATERIAL GROUND | FINENESS
OATS 2.70
BARLEY 3.60
SHELLED CORN 3.00
EAR CORN 3.00
ALFALFA 1.90
SOY BEAN HAY 3.00
CORN STOVER 3.20
CORN STOVER
SOY BEAN HAY
ALFALFA
OATS
EAR CORN
BARLEY
SHELLED CORN
NO LOAD—MILL SPEED = 3350 R.P.M.
HORSE POWER
POUNDS OF FEED GROUND PER HOUR

Fig. 26

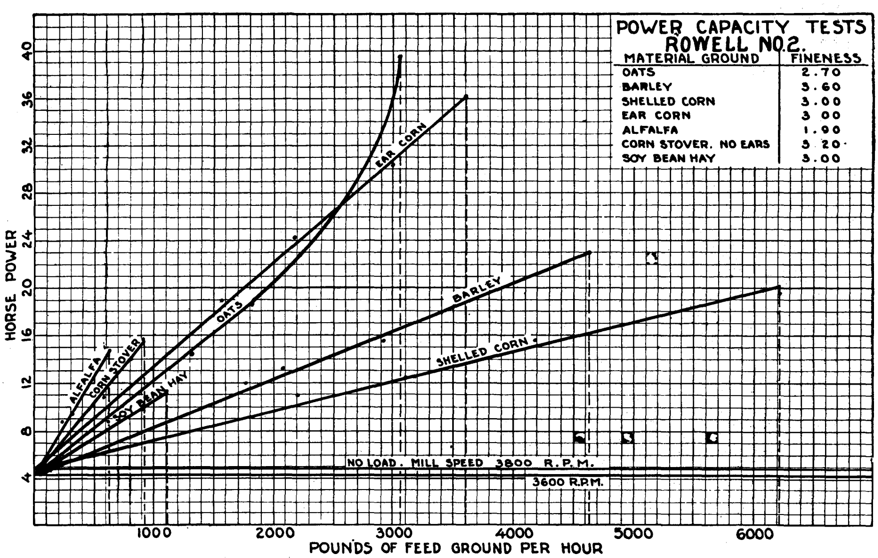

POWER CAPACITY TESTS
ROWELL NO.2.
MATERIAL GROUND | FINENESS
OATS 2.70
BARLEY 3.60
SHELLED CORN 3.00
EAR CORN 3.00
ALFALFA 1.90
CORN STOVER. NO EARS 3.20
SOY BEAN HAY 3.00
ALFALFA
CORN STOVER
SOY BEAN HAY
OATS
EAR CORN
BARLEY
SHELLED CORN
NO LOAD. MILL SPEED 3800 R.P.M.
3600 R.P.M.
HORSE POWER
POUNDS OF FEED GROUND PER HOUR

Fig. 27

TEST DATA
Hammer Mill—Stover No. 90

Test No.	Length of test (Min.)	Material ground	Test weight per bushel	Temperature of material (°F.) Before grinding	After grinding	Increase in Temp. (°F.)	Moisture content Before grinding	Relative humidity (Room)	Screen number or name (In.)	Speeds R. P. M. Power unit	Mill	Horse-power at mill pulley Mill empty	Mill under load	Pounds ground	Pounds per hour	Pounds per H. P. hour	Fineness modulus
1	3	Oats	32	70	88	18	10.9	57	1/4	1030	3550	3.2	22.0	118	2360	107	2.62
2	3	Oats	32	70	89	19	10.9	57	1/4	980	3540	....	18.2	97	1940	107	2.60
3	3	Oats	32	70	88	18	10.9	57	1/4	960	3520	....	13.7	79	1580	115	2.66
4	3	Oats	32	70	84	14	10.9	57	1/4	960	3520	....	11.8	65	1300	110	2.84
5	3	Barley	40	70	73	3	8.3	42	5/16	910	3260	....	22.1	195½	3910	177	3.58
6	3	Barley	40	70	73	3	8.3	42	5/16	910	3270	....	16.8	150½	3010	179	3.55
7	3	Barley	40	70	72	2	8.3	42	5/16	910	3280	....	12.5	111	2220	178	3.57
8	3	Barley	40	70	72	2	8.3	42	5/16	830	3230	....	10.0	84	1680	168	3.66
9	3	Shelled corn	52	70	83	13	11.0	48	1 1/4	1060	3620	....	26.8	451	9030	337	3.06
10	3	Shelled corn	52	70	83	13	11.0	48	1 1/4	1060	3650	....	17.1	255	5100	298	3.19
11	3	Shelled corn	52	70	80	10	11.0	48	1 1/4	1040	3680	....	11.0	138	2760	251	3.13
12	3	Shelled corn	52	70	80	10	11.0	48	1 1/4	1000	3630	....	9.1	104	2080	228	3.05
13	3	Ear corn	....	70	85	15	10.0	48	7/16	1050	3650	....	20.3	146½	2930	144	2.94
14	3	Ear corn	....	70	86	16	10.0	48	7/16	990	3620	....	12.8	86	1720	134	2.85
15	3	Ear corn	....	70	85	15	10.0	48	7/16	1010	3700	....	14.8	100½	2010	136	2.98
16	3	Ear corn	....	70	83	13	10.0	48	7/16	985	3656	....	9.4	52	1040	112	2.89
17	3	Alfalfa	....	70	81	11	8.0	44	1/8	1000	3810	....	12.6	28½	570	45	1.94
18	4	Alfalfa	....	70	80	10	8.0	44	1/8	985	3720	....	11.4	36	540	47	1.98
19	3	Alfalfa	....	70	78	8	8.0	44	1/8	990	3810	....	8.3	14	280	34	2.03
20	3	Alfalfa	....	70	78	8	8.0	44	1/8	990	3802	....	10.4	23½	470	45	1.98
21	3	Soybean hay	....	70	73	3	10.9	42	3/4	990	3800	....	8.7	40½	810	93	2.92
22	3	Soybean hay	....	70	73	3	10.9	42	3/4	970	3780	....	7.4	31½	630	85	3.00
23	3	Soybean hay	....	70	72	2	10.9	42	3/4	960	3730	....	9.1	42	840	92	3.05
24	....	No test run because of low capacity of mill				....	....	....	....	....	....	....	....	....	....	....	....
25	3	Corn stover	....	70	76	6	12.0	48	3/4	*	3680	....	9.5	18½	370	39	3.14
26	3	Corn stover	....	70	79	9	12.0	48	3/4	*	3675	....	9.6	21½	430	45	3.20
27	3	Corn stover	....	70	77	7	12.0	48	3/4	*	3680	....	8.8	18	360	41	3.25
28	....	No test run because of low capacity of mill				....	....	....	....	....	....	....	....	....	....	....	....
9A	....	Shelled corn	Test for maximum coarseness						1 1/4	....	3200	....	....	....	....	....	3.38
1-C	4	Oats	32	....	....	....	10.4	....	1/4	....	3200	6.0	22.9	190½	2858	125	3.00
2-C	3	Oats	32	....	....	....	10.4	....	1/4	....	3000	....	27.7	106¼	2125	77	2.56
3-C	3	Oats	32	....	....	....	10.4	....	1/4	....	3450	....	13.3	81½	1630	122	2.70
4-C	4	Oats	32	....	....	....	10.4	....	1/4	....	3500	....	31.3	254	3810	122	2.66
5-C	2	Shelled corn	54	....	....	....	12.8	....	3/4	....	3400	....	22.2	259	7770	350	3.18
6-C	3	Ear corn	....	....	....	....	13.0	....	7/16	....	3500	....	32.5	256¼	5130	158	3.12
7-C	4	Ear corn	....	....	....	....	13.0	....	7/16	....	3500	....	21.7	217½	3263	150	3.10
8-C	2	Alfalfa	....	....	....	....	12.0	....	1/8	....	3500	....	19.5	40	1200	62	2.01

Tests 1-C to 8-C, inclusive, were run after the manufacturer made some changes in design of the mill. As will be seen from the data secured, the changes added greatly to the efficiency of operation of the mill. The mill showed improved performance and operated with a gratifying success.

*Impossible to get engine speed.

TEST DATA

Hammer Mill—Bluestreak No. 20—Triple Reduction Process

Test No.	Length of test (Min.)	Material ground	Test weight per bushel	Temperature of material (°F.)		Increase in Temp. (°F.)	Moisture content	Relative humidity (Room)	Screen number or name (In.)	Speeds R. P. M.		Horse-power at mill pulley		Pounds ground	Pounds per hour	Pounds per H. P. hour	Fineness modulus
				Before grinding	After grinding		Before grinding			Power unit	Mill	Mill empty	Mill under load				
1	5	Oats	32	70	84	14	10.8	48	1/4	1020	1695	6.5	17.2	300	3600	209	2.67
2	5	Oats	32	70	82	12	10.8	48	1/4	1015	1700	....	14.0	227	2724	195	2.64
3	5	Oats	32	70	82	12	10.8	48	1/4	1012	1700	....	11.5	143	1716	149	2.68
4	5	Oats	32	70	83	13	10.8	48	1/4	1010	1700	....	9.6	82	984	103	2.61
5	5	Barley	41.5	70	76	16	10.4	48	3/4	940	1600	....	19.4	533	6396	329	3.71
6	5	Barley	41.5	70	76	16	10.4	48	3/4	958	1605	....	11.0	240	2880	262	3.57
7	5	Barley	41.5	70	76	16	10.4	48	3/4	958	1605	....	9.6	151	1812	189	3.57
8	5	Barley	41.5	70	77	17	10.4	48	3/4	956	1605	....	8.4	98	1176	140	3.55
9	2	Shelled corn	52.0	71	86	15	11.0	40	1 1/2	840	1400	....	34.0	417½	12525	368	3.11
10	2	Shelled corn	52.0	71	90	19	11.0	40	1 1/2	840	1640	....	21.6	224	6720	311	2.78
11	2	Shelled corn	52.0	71	68	17	11.0	40	1 1/2	830	1600	....	16.3	140	4200	258	2.82
12	2	Shelled corn	52.0	71	91	20	11.0	40	1 1/2	800	1600	....	11.0	76	2280	207	2.81
13	5	Ear corn	....	70	76	6	12.8	42	1 1/2	930	1800	....	30.0	396	4752	158	3.00
14	3	Ear corn	....	70	76	6	12.8	42	1 1/2	920	1800	....	24.5	191	3820	156	3.04
15	3	Ear corn	....	70	78	8	12.8	42	1/2	930	1800	......	18.6	122	2440	131	2.91
16	3	Ear corn	....	70	79	9	12.8	42	1/2	900	1750	......	40.0	350	7000	175	3.10
17	4	Alfalfa	....	70	80	10	7.3	42	1/8	980	1800	....	34.3	137	2055	60	1.87
18	3	Alfalfa	....	70	76	6	7.3	42	1/8	940	1800	....	20.1	52½	1070	54	1.90
19	3	Alfalfa	....	70	78	8	7.3	54	1/8	960	1800	....	25.6	76	1520	59	1.89
20	3	Alfalfa	....	70	75	5	7.3	54	1/8	960	1800	....	16.3	45½	910	56	1.79
21	3	Soybean hay	....	70	95	25	10.3	42	1 1/2	900	1720	....	15.0	68	2040	136	2.89
22	2	Soybean hay	....	70	92	22	10.3	42	1 1/2	860	1630	....	16.8	86½	2595	154	2.87
23	2	Soybean hay	....	70	92	22	10.3	42	1 1/2	860	1620	....	10.9	46	1380	126	2.79
24	Short of material. Did not run.			....	....	....	....	....	....	....	....	....	....	....	....	....	....
25	3	Corn stover	....	70	92	22	10.2	42	3/4	1010	1800	....	25.0	82	1640	66	3.10
26	3	Corn stover	....	70	91	21	10.2	42	3/4	1010	1820	....	23.9	77½	1550	65	3.09
27	3	Corn stover	....	70	95	25	10.2	42	3/4	980	1800	....	16.8	46½	930	55	3.12
28	3	Corn stover	....	70	93	23	10.2	42	3/4	950	1800	......	14.9	39	780	52	3.08
.....	....	Shelled corn	Maximum coarseness..................								1450	......	....	....	....	....	3.12

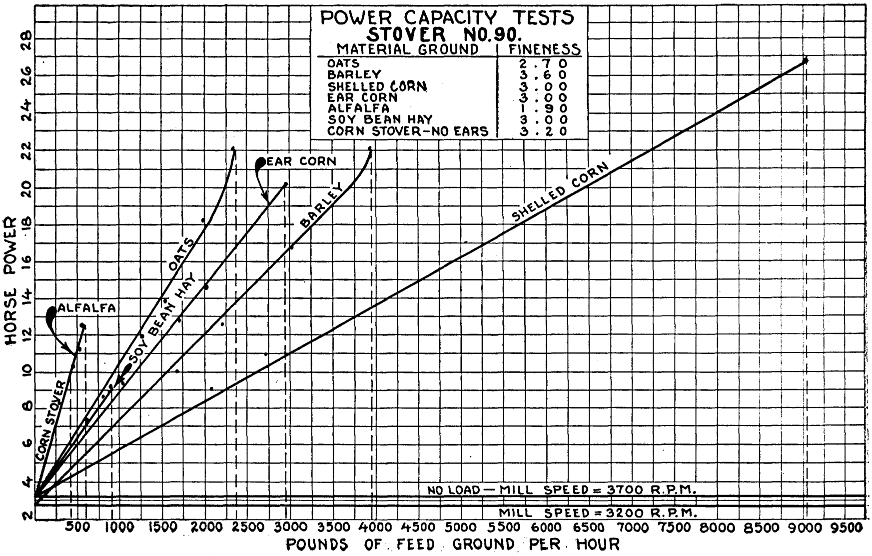

POWER CAPACITY TESTS
STOVER NO. 90.
MATERIAL GROUND | FINENESS
OATS 2.70
BARLEY 3.60
SHELLED CORN 3.00
EAR CORN 3.00
ALFALFA 1.90
SOY BEAN HAY 3.00
CORN STOVER-NO EARS 3.20
EAR CORN
BARLEY
SHELLED CORN
OATS
SOY BEAN HAY
ALFALFA
CORN STOVER
NO LOAD—MILL SPEED = 3700 R.P.M.
MILL SPEED = 3200 R.P.M.
HORSE POWER
2 4 6 8 10 12 14 16 18 20 22 24 26 28
500 1000 1500 2000 2500 3000 3500 4000 4500 5000 5500 6000 6500 7000 7500 8000 8500 9000 9500
POUNDS OF FEED GROUND PER HOUR

Fig. 28

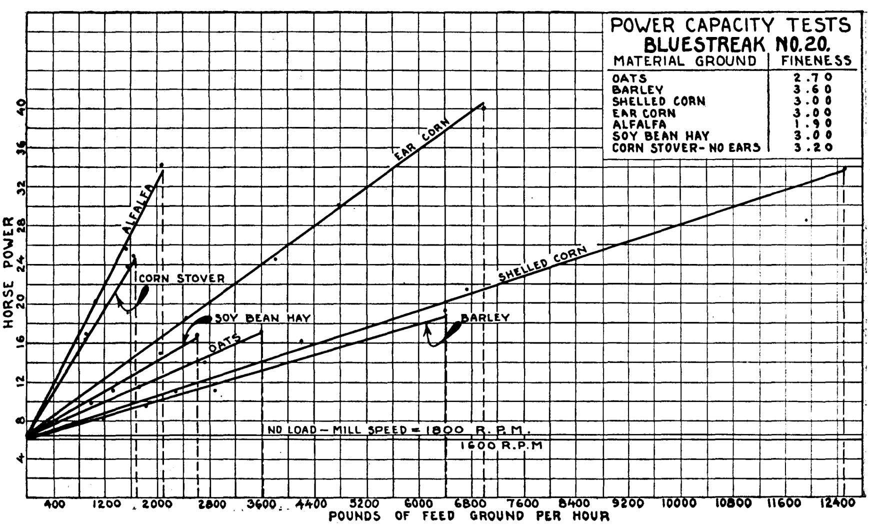

POWER CAPACITY TESTS
BLUESTREAK NO. 20.
MATERIAL GROUND | FINENESS
OATS 2.70
BARLEY 3.60
SHELLED CORN 3.00
EAR CORN 3.00
ALFALFA 1.90
SOY BEAN HAY 3.00
CORN STOVER- NO EARS 3.20
EAR CORN
ALFALFA
CORN STOVER
SOY BEAN HAY
OATS
SHELLED CORN
BARLEY
NO LOAD - MILL SPEED = 1800 R.P.M.
1600 R.P.M
HORSE POWER
4 8 12 16 20 24 28 32 36 40
400 1200 2000 2800 3600 4400 5200 6000 6800 7600 8400 9200 10000 10800 11600 12400
POUNDS OF FEED GROUND PER HOUR

Fig. 29

FEED MILL EFFICIENCY

Efficiency in feed mill operation depends on the kind and nature of materials to be ground, type of mill and equipment used, fineness of grinding, and the operation of the mill. Grains which contain a large amount of fiber are usually hard to grind and consequently require a high power consumption per unit of weight. Grains which are high in starch content are usually easy to grind, thereby requiring a low power consumption, or, in other words, more pounds ground per horsepower per hour. Other grains may contain a high percentage of oil or water which raises the power requirements. Roughages which are high in fiber content require more power to grind and the capacity of the mill (by weight) is generally low, which naturally lowers the pounds ground per horsepower per hour.

EFFECT OF MOISTURE CONTENT OF GRAIN ON POWER REQUIREMENTS

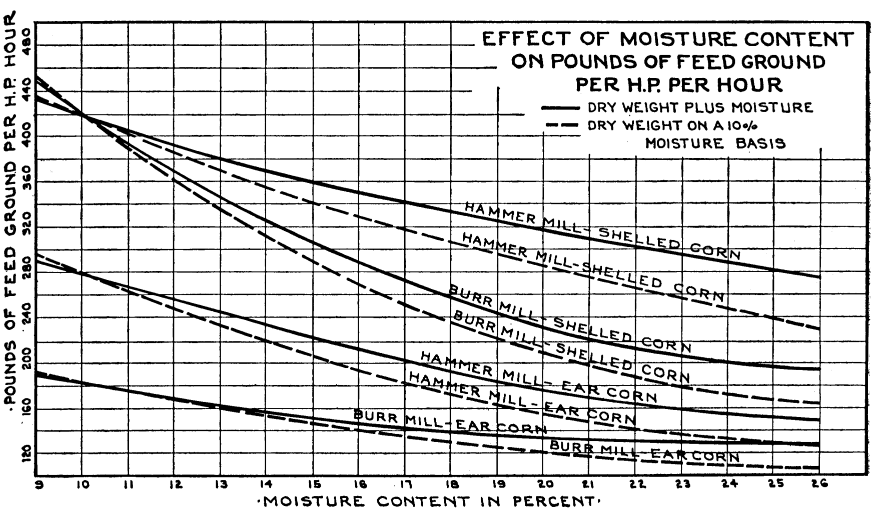


Fig. 30

Figure 30 is a chart showing the effect of moisture in the grain on power requirements. The straight line curves show the pounds of feed ground per horsepower per hour at the actual moisture content. The broken line curves show the pounds of feed ground per horsepower per hour figured on a 10 per cent moisture basis. In other words, the excess moisture above 10 per cent was omitted in the weights.

Very nearly twice the number of pounds of feed containing 10 per cent moisture can be ground per horsepower per hour over that containing 25 per cent moisture. The curves further show that moisture in the grain has a greater effect upon increased horsepower than moisture in the cob.

TYPE OF MILL AND EQUIPMENT

The type of mill and its equipment have considerable bearing on the efficiency of grinding feeds. One type of mill may be more adaptable for one kind of feed than for another; it may give good results on coarse grinding and poor results on fine grinding. It may have a high capacity on some feeds and very low on others.

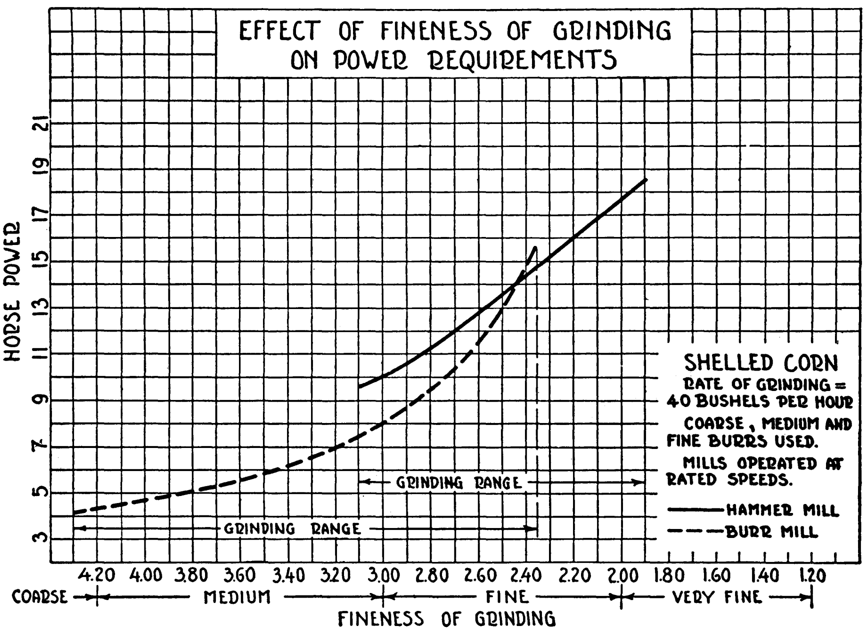


Fig. 31

For grinding shelled corn or other grains having a high, dry starch content, the burr mill is very satisfactory. However, this applies only to medium or coarse grinding. For fine grinding on these products or on oats grinding, the hammer mill shows better results than the burr mill. On the shelled corn grinding, the burr mills were grinding to 3.90 and the hammer mills to 3.00. This was made necessary because it was impossible for the hammer mills to grind to 3.90 even with the largest screen installed and at a speed greatly reduced from the rated R. P. M. of the mill.

If a speed-jack is necessary this installation increases the no-load power requirement of the mill and therefore may lessen slightly the pounds of feed ground per horsepower per hour. On the other hand, if the tractor is belted directly to the mill rotor a small mill pulley is necessary and considerable belt slippage may exist on heavy loads. The type of grinding burrs used also affects the power consumption, capacity of the mill, and the quality of the ground product. Although fine grinding can be done on burrs other than those of a fine type, it is not to be recommended. A force-feed feed table is desirable, especially when grinding roughages. It adds to the no-load power requirement of the mill but is compensated for by increased efficiency due to even feeding. For roughage and ear corn grinding a cutter head is desirable as a first reduction process.

EFFECT OF FINENESS OF GRINDING ON POWER REQUIREMENTS

Figures 31, 32, and 33 are charts showing what effect fineness of grinding has on the power requirements of burr and hammer mills. The results are the averages of four hammer mills and three burr mills. Two of the hammer mills were equipped with speed-jacks and two were driven directly.

On shelled corn grinding (Figure 31) the burr mill shows a lower power consumption on coarse grinding than that of the hammer mill at the same fineness. At a modulus of fineness under 2.45 the hammer mill requires less power than that of the burr mill. This indicates that the burr mill will grind shelled corn at a coarse grade of fineness more efficiently than the hammer mill, but for fine grinding the reverse is true. The range for fineness of grinding is greater for the burr mill when a full set of burrs is used. The curves further show that the burr mill will produce coarser grinding.

On grinding barley (Figure 32) the burr mill again requires less power for coarse grinding but requires more than the hammer mill when a modulus of fineness of 2.30 or under is reached. The range for fineness of grinding is practically equal, the hammer mill grinding at a much coarser grade than was the case with the shelled corn grinding.

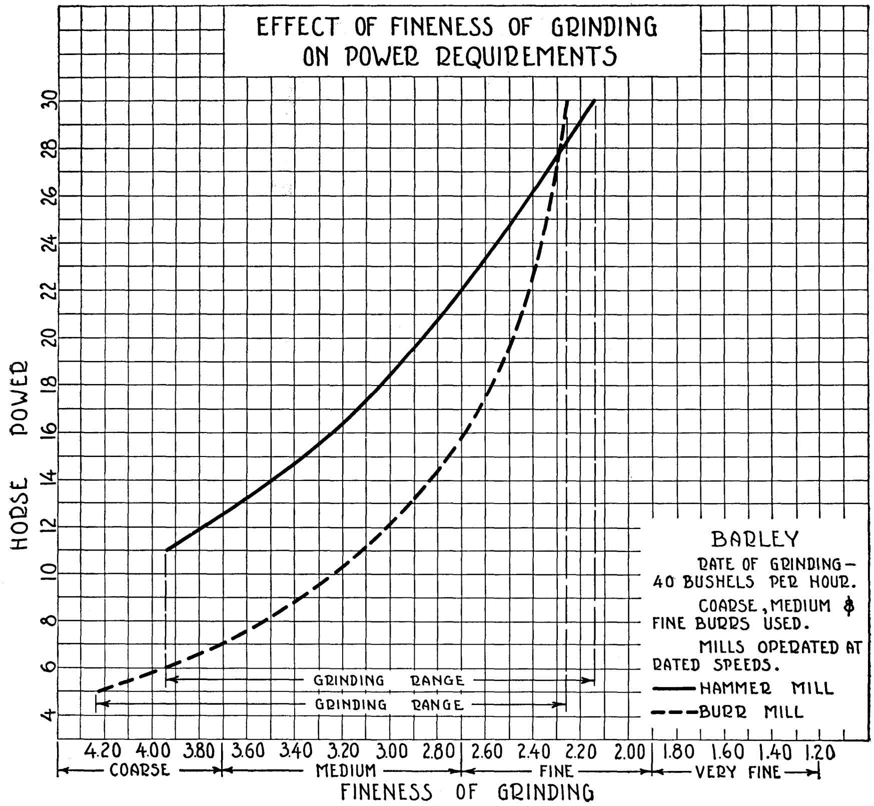


Fig. 32

On oats grinding (Figure 33) entirely different results are obtained than those secured from the preceding tests on shelled corn or barley. The nature of the grain differs in having a higher fiber content, which works to the disadvantage of burr mills. On the burr mill power capacity tests, very high temperatures of the ground material were obtained on oats. This tends to prove that a great amount of friction is created between the burrs by a rubbing rather than a shearing process, which naturally increases the horsepower at a rapid rate, especially as the grade of fineness becomes finer.

Only on very coarse grinding does the burr mill exceed the hammer mill in efficiency. The curves show further that the ratio of horsepower to fineness from coarse to fine grinding increases much more rapidly in oats than it does in barley or shelled corn. The range for fineness of grinding is greater for the hammer mill, which is the reverse of the barley and shelled corn tests.

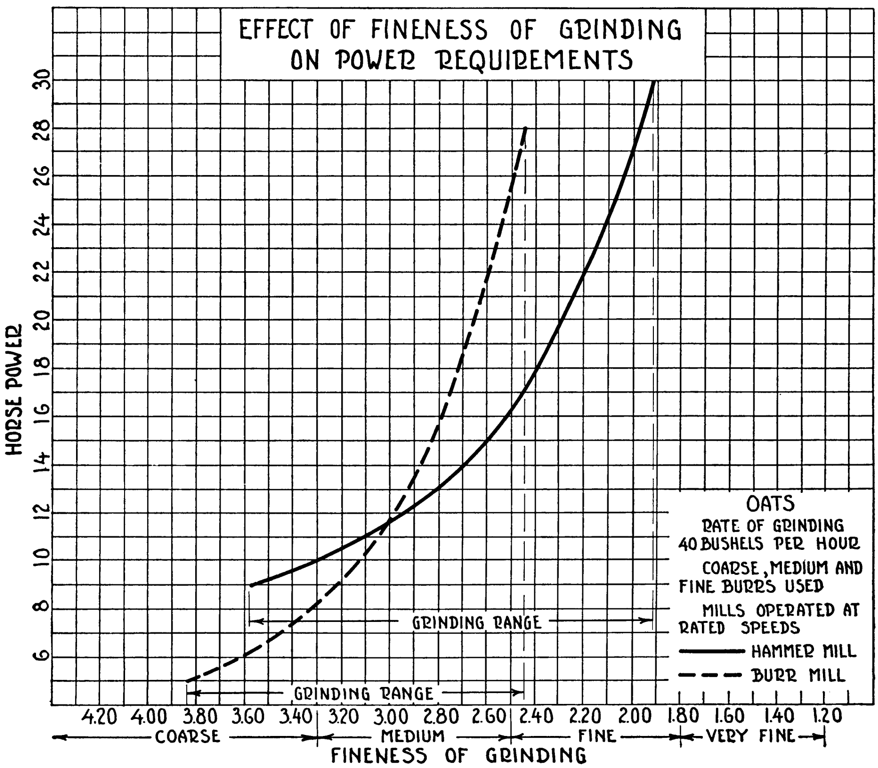


Fig. 33

Regularity of feeding plays an important part in obtaining high efficiency in feed mill operation. This is particularly true in grinding roughages with hammer mills where it is very easy to produce slugging if the mill is not fed evenly and steadily. Usually the mill will have the highest efficiency when working at full capacity or very close to it. It should not, however, be overloaded to a point where the fan or elevator is not capable of removing the ground material from the settling chamber at a rate commensurate with the capacity of the mill. An overloaded fan will very quickly lower the efficiency of the mill. The direction of rotation of the rotor on a hammer mill and the point on the periphery of the hammers at which the materials are fed have also an influence on efficiency. From observation made, the hammers should never revolve toward the feed hopper or table, as the value of suction is lost and heavy leakage results back through the feed hopper. The speed of the mill should be held as nearly as possible to the manufacturer's rating, at least until further investigational work has been done to determine the most desirable speeds.

EFFECT OF SPEED OF HAMMER MILLS ON FINENESS OF GRINDING

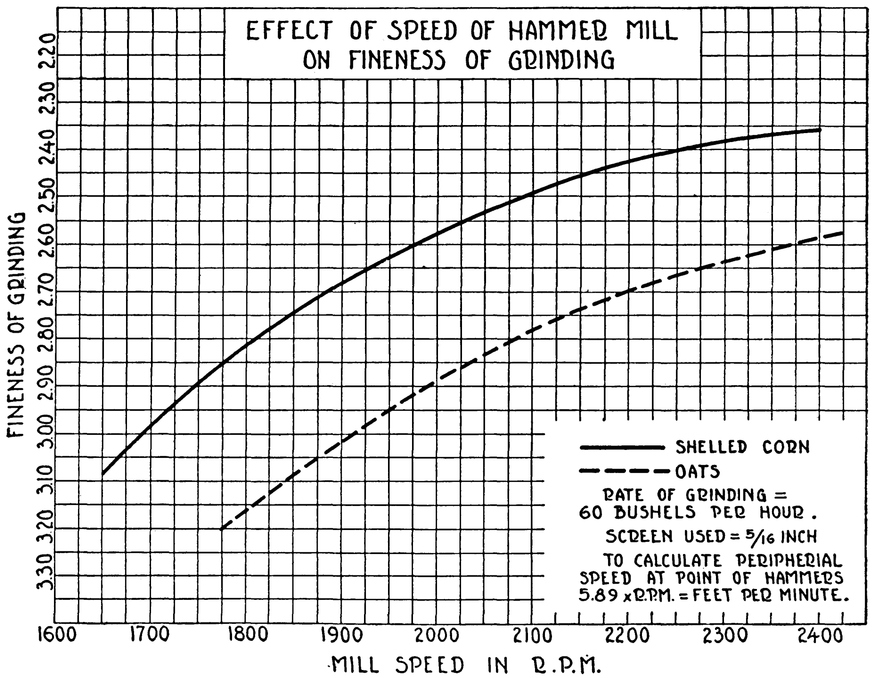


Fig. 34

Figure 34 indicates that a slower speed produces a coarser product and a higher speed a finer product. If the speed of the mill is reduced much below its rated R. P. M., trouble may result from the inability of the fan to elevate the material. This is especially true in oats grinding, as this grain is very susceptible to plugging either in the fan, delivery pipe, or feed collector.

EFFECT OF SIZE OF SCREENS ON FINENESS OF GRINDING

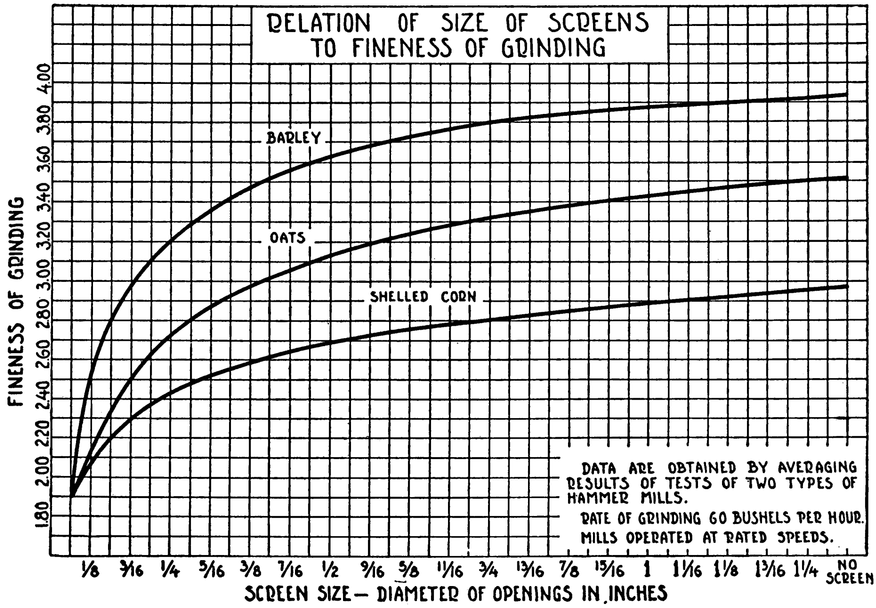


Fig. 35

The majority of hammer mills carry a large number of screens of various sizes. For ordinary grinding on the farm it is not necessary to carry the full assortment of screens, but it is hard to determine what size screens to obtain, inasmuch as the same sized screen produces different finenesses with different grains. Figure 35 shows that the fineness of grinding varies over greater increments from screens of 1/16″ to ½″ in size than those from ½″ to 1¼″ in size. It must be remembered that the above data were taken from mills of the larger type, and that the results may differ with the smaller units. For average grinding conditions the following table may serve to give some idea as to the screens to use for the grade of fineness desired.

TABLE 4.—Approximate Size of Screens for Various Finenesses of Grinding

Grades of fineness of grinding	Shelled corn	Barley	Oats
	Inch	*Inch*	*Inch*
Coarse	*	1 1/4	1 1/4 to no screen
Medium to coarse	*	1/2	3/4
Medium	*	1/4	5/16
Fine to medium	1 1/4	3/16	3/16
Fine	1/4	1/8	1/8
Very fine to fine	1/8	3/32	3/32
Very fine	3/32	1/16	1/16

*Mills on test could not produce grade of fineness even with no screen installed.

UNIFORMITY OF SIZE OF GROUND PARTICLES

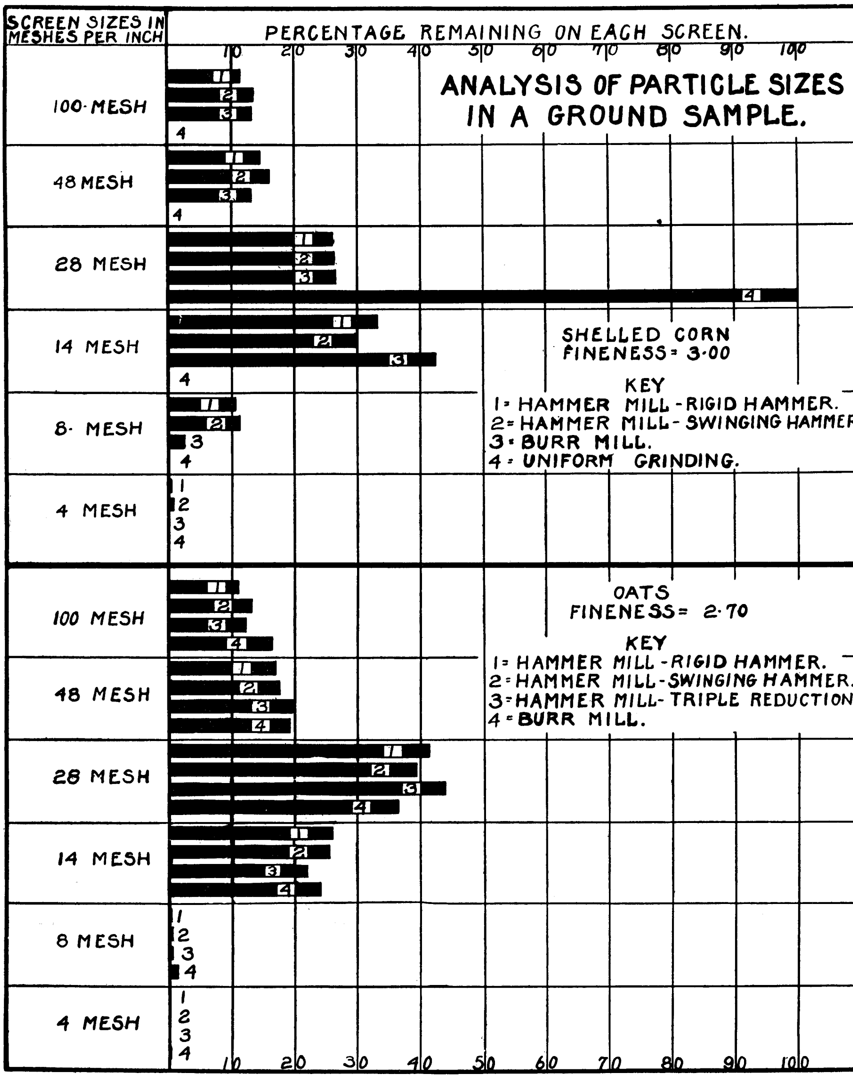


Fig. 36

The quality of ground feed includes the uniformity in size of the ground particles. A minimum amount of finely powdered material is desired. Figure 36 shows the analysis of particle sizes in ground samples of 250 grams each. These samples were screened through screens of various numbers of meshes per inch.

The percentage which remained on each screen is shown by the bars on the chart. A small amount always passed through the 100-mesh screen, varying from 1 to 5 per cent.

The samples were taken from burr mills and hammer mills of the various types. The results from the mills are compared with an ideal or what might be termed uniform grinding.

By observing the chart one may note that there is a lack of uniformity in the size of particles in a feed sample ground by any of the mills and entirely too much powdered material. The chart further shows that there is very little difference in uniformity of size of particles in grinding regardless of the type of mill used.

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